

TITLE OF THE INVENTION

Modular Transportable System for SAGD Process

FIELD OF THE INVENTION

A transportable modular process particularly well suited for exploiting a remote heavy oil resource or the like for example using steam assisted gravity drainage technology or the like.

BACKGROUND OF THE INVENTION

The current practice for Steam Assisted Gravity Drainage (SAGD) facilities is to install a large, permanent, centrally located SAGD processing facility on a large oil sands lease. A number of well pads, from which multiple (typically 6 to 10) SAGD well pairs are drilled, are connected to the Central Processing Facility (CPF). Interconnecting pipelines are then required to deliver steam from the CPF to the well pads and transport the produced bitumen and water to the SAGD processing facility for treatment and ultimately shipped for sale. As the resource accessed by individual wells becomes depleted, new wells are drilled requiring additional and presumably longer interconnecting pipelines between the new well pads and the processing facility.

The above described concept requires significant injections of capital and is only viable for large contiguous oil sands resources to provide enough bitumen to support the facility through its planned lifetime. In addition, these facilities have demonstrated very unreliable, often associated with frequent equipment maintenance or failure or inadequate process control. Some of the major contributing factors to this poor reliability performance include:

- The use of labor intensive complex water treatment processes such as hot/warm lime softeners, regenerated oil removal and sand filters, weak acid cation (WAC) ion exchange system and once through steam generators (OTSG).
- Inadequate use of automated process control resulting in over-dependence on manual operator intervention
- Non-continuous process whereby fluids undergo some degree of processing followed by transfer in and out of the tank farm only to undergo further processing.

In addition, the environmental impact of current oil sands production techniques are raising significant international and domestic concerns and present a real threat to the oil sands industry as a whole. Current SAGD facilities have a large footprint when considering the land disturbance for the CPF, well pads, interconnecting roads and pipelines and camp facilities for construction, maintenance and operating staff. In addition, they have significant water use and disposal requirements and are energy intensive, leading to greenhouse gas generation. There is an opportunity to develop new in situ recovery techniques that minimize the overall environmental impact.

Given that most of the large contiguous reserves amenable to mining or large scale in situ recovery are owned and operated by major oil companies, the next wave of oil sands development activity will need to focus on scattered pods or thinner pay zones of oil sands. This cannot be achieved with the current in situ thermal recovery techniques. Smaller scale facilities that can be easily redeployed will be needed for this for the smaller pods of oil as they will frequently not support an economic project life of 20+ years. The notion of reducing scale, operating and capital costs is counter to the "economy of scale" model, but was achieved with thoughtful fit-for-purpose engineering design.

SUMMARY OF THE INVENTION

According to a preferred embodiment of the invention there is provided a transportable modular process for exploiting a remote heavy oil resource or the like using steam assisted gravity drainage technology or the like. Said process comprising transportable preassembled and commissioned / tested modules which when interconnected adjacent to said remote heavy oil resource provide the ability to exploit said heavy oil resource or the like. Each module being preassembled and commissioned at the time of manufacture with the necessary piping and electrical wiring and other essential equipment for each module prior to being transported to adjacent the resource. Each module being, when transported to adjacent said resource, able to be readily interconnected with other process modules to enable an entire SAGD process or the like to be constructed adjacent said resource, wherein once said resource is depleted said modular process may be disassembled and transported to a different remote resource, and subsequently reassembled at said different remote resource in the same manner. Said process comprises several transportable modules selected from the following group of modules:

- a) Oil and water separation modules
- b) Flash cooling of produced water rather than the convention;
- c) Vapor Recovery Unit (VRU) Ejector and fuel gas system modules
- d) Compact evaporator with an external demister or other evaporators available on the market and modified where necessary.
- e) Cooling system modules (for example glycol cooling system)
- f) Boiler feed water supply and chemical addition
- g) Boiler modules
- h) Power Generation modules

and once selected, transported, assembled and securely interconnected, providing a complete SAGD process or the like for exploiting said remote resource.

The modules are designed to be direct coupled on one or two levels with pipe racks integral to each module. This reduces the overall size of the complete SAGD process plant and minimizes the need for long pipe racks typical of current SAGD facilities. This is also a critical feature required to support the portability concept incorporated into the design.

According to another embodiment of the invention, there is provided a transportable modular system for hydrocarbon extraction using a Process or the like. Said system comprising of several of the following interconnected modules assembled into said process at a desired site, but each module being commissioned where constructed prior to being transported:

- a) Module 1 comprising inlet coolers, an inlet separator, a de-sand unit, and Free Water Knock-Out and Oil Treating vessels.
- b) Module 2 comprising of an Induced Gas Floatation Unit, distillate tank and Dilbit cooler.
- c) Module 3 comprising the evaporator exchanger.
- d) Module 4 comprising an evaporator compressor, evaporator recirculation pumps and chemical addition machinery.
- e) Module 5 comprising boiler feed water pumps, instrument air systems and electrical systems.
- f) Module 6 comprising a boiler.
- g) Module 7 comprising power generation and a Heat Recovery Steam Generator.
- h) Module 8 comprising a glycol cooler or other cooling system.
- i) Module 9 comprising a flash drum, flash drum condenser, and dump condenser.

- j) Module 10 comprising a glycol expansion drum, fuel gas drum, and heat exchangers.

Said modules being assembled and interconnected into said process by the provision of the boundaries of said modules being adapted to be securely connected by mechanical means, and by connecting electrical lines and piping runs extending from module to module.

It is understood that the defined equipment of those modules might be rearranged differently or occupy less or more than ten modules. Ten modules provide just one of the preferred non limiting embodiments of the invention for the ease of reference to the drawings.

According to yet another aspect of the invention, in the modular system described above the modules are interconnected and once this is done further comprising the necessary equipment, machinery, piping and tubing, fastening means, electrical lines and sets of controllers required for the operation of the modular process/system.

Preferably at least one of the said above modules is selected from the following list of:

- a) Third party evaporator modified to incorporate KemeX weir and a set of controllers; and/or
- b) Compact evaporator with an external compressor suction drum; and/or
- c) VRU Ejectors; and/or;
- d) Flash cooling system for produced water as opposed to conventional heat exchanger.

According to yet another aspect of the invention there is provided a method of transporting a SAGD process or the like to a remote hydrocarbon reservoir comprising:

- Defining modules which collectively substantially make up the process when assembled together to substantially form said process including preferably modules 1 to 10 listed above.
- Constructing said modules adapted to be fitted on a tractor trailer, rail car, barge or the like.
- Transporting said modules to the remote location using trucks or other suitable means of transportation.
- Assembly of said modules at the remote location into said SAGD process or the like and using the system for extraction of hydrocarbons.

- Using the SAGD process or the like at the remote location.

According to still another aspect of the invention there is provided a method of constructing a modular transportable SAGD system comprising modules listed above.

- First defining modules which when assembled collectively make up the process for extraction of hydrocarbons.
- Second constructing separate interconnecting modules adapted to be transported by a truck or other means of transportation.
- Third commissioning of the system of the modules at the manufacturing location, then disassembling the system into the modules, and finally preparing the modules for transportation to the remote location.

According to yet another aspect of the invention there is provided a use of a system described above further comprising steps of:

- a) Constructing and assembling the modules at a manufacturing location(s) different from the final plant site adjacent the resource.
- b) Assembling the system from the modules at the manufacturing location(s).
- c) Testing and commissioning the modules and/or the combination of modules at the manufacturing location(s).
- d) Disconnecting the modules and positioning them on tractor trailers, rail cars or other suitable means of transportation.
- e) Transporting the modules to adjacent the oil sands or heavy oil resource location.
- f) Assembling the system from the modules at the remote location.
- g) Extracting hydrocarbons from the oil sands or heavy oil deposits using the assembled system.
- h) If necessary, dissembling, relocating and reassembling the system at another remote location to extract hydrocarbons from the oils sands or heavy oil at the new location.

It is important to note that separate modules can be manufactured and assembled at single location or at multiple locations and tested at those locations or transported to one location and commissioned prior to the delivery to the remote location.

According to another aspect of the invention there is provided a process comprising several modules selected from the following group of modules:

- Oil and water separation modules;
- Flash cooling of produced water rather than the conventional heat exchanger or the like;
- Vapor Recovery Unit (VRU) Ejector and fuel gas system modules;
- Compact evaporator with an external demister or other evaporators available on the market and modified where necessary;
- Cooling system modules (for example glycol cooling system);
- Boiler feed water storage/supply and chemical addition modules;
- Boiler modules;
- Power Generation modules

thus providing a complete SAGD process or the like for exploiting a remote resource.

According to another aspect of the invention there is provided a process for hydrocarbon extraction from a resource, using an SAGD process, said process comprising the following modules:

- a) Module 1 comprising inlet coolers, an inlet separator, a de-sand unit, and Free Water Knock-Out and Oil Treating vessels.
- b) Module 2 comprising of an Induced Gas Flootation Unit, distillate tank and Dilbit cooler.
- c) Module 3 comprising an evaporator exchanger.
- d) Module 4 comprising an evaporator compressor, evaporator recirculation pumps and chemical addition machinery.
- e) Module 5 comprising boiler feed water pumps, instrument air systems and electrical systems.
- f) Module 6 comprising a boiler.
- g) Module 7 comprising power generation and a Heat Recovery Steam Generator.
- h) Module 8 comprising a glycol cooler or other cooling system.
- i) Module 9 comprising a flash drum, flash drum condenser, and dump condenser.
- a) Module 10 comprising a glycol expansion drum, fuel gas drum, and additional heat exchangers.

wherein said modules or the like being interconnected into said process in order to exploit said hydrocarbon resource.

The current objective is to engineer, construct, and operate a complete SAGD processing facility with a number of modules that are intended to be assembled and commissioned off site, relocated and joined with other modules to create the entire SAGD process and, when the resource is depleted or proven uneconomical, disassembled and relocated to a different resource to be reassembled to exploit said resource at that site.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1 is a Conventional Process Flow Diagram (Evaporator/Boiler Design).

Figure 2 is a 1ⁿ Site Flow Diagram illustrated in one embodiment of the invention.

Figure 3 is an UltraLite Flow Diagram with evaporator having an external demister illustrated in one embodiment of the invention.

Figure 4 is a Conventional FWKO and Treater.

Figure 5 is a Desand/FWKO/Treater illustrated in one embodiment of the invention.

Figure 6 is a Conventional Produced Water Cooler and Skim Tank.

Figure 7 is Produced Water Flash Drum, Condenser illustrated in one embodiment of the invention.

Figure 8 is a Dump Condenser illustrated in one embodiment of the invention.

Figure 9 is a Vapour Recovery Units Systems illustrated in one embodiment of the invention.

Figure 10 is a Desand/FWKO Treater Controls illustrated in one embodiment of the invention.

Figure 11 is a Temperature Profile Comparison between conventional system and the systems of the current invention illustrated in one embodiment of the invention.

Figure 12 is a layout of the assembled modular SAGD plant with ten modules illustrated in one embodiment of the invention.

Figure 13 is an isometric view of module 1 comprising inlet coolers, inlet separator, de sand, FWKO treater vessel illustrated in one embodiment of the invention.

Figure 14 is an isometric view of module 2 comprising IGF and Dilbit cooler and module 10 comprising evaporator with two heat exchangers illustrated in one embodiment of the invention.

Figure 15 is an isometric view of module 3 comprising evaporator compressor, evaporator recirculation parts and chemicals additives illustrated in one embodiment of the invention.

Figure 16 is an isometric view of module 4 comprising pumps, air and electrical system illustrated in one embodiment of the invention.

Figure 17 is an isometric view of module 6 comprising a package boiler illustrated in one embodiment of the invention.

Figure 18 is an isometric view of module 5 comprising power generation and HRSG illustrated in one embodiment of the invention.

Figure 19 is an isometric view of module 7 comprising a glycol cooler illustrated in one embodiment of the invention.

Figure 20 is an isometric view of module 8 comprising a flash drum, flash drum condenser, and dump condenser illustrated in one embodiment of the invention.

Figure 21 is an isometric view of module 9 comprising a glycol expansion drum, fuel gas drum, and small exchangers illustrated in one embodiment of the invention.

Figure 22 is an isometric view of modules 4, 5 and 6 illustrated in one embodiment of the invention.

Figure 23 is an isometric view of modules 1,2 and 10 illustrated in one embodiment of the invention while Module 10 comprises an evaporator with two heat exchanger towers.

Figure 23A is an isometric view of modules 1, 2 and 10 illustrated in second embodiment of the invention while Module 10 comprises an evaporator with a single heat exchanger tower.

Figure 24 is an isometric view of modules 2,8 and 10 illustrated in one embodiment of the invention.

Figure 25 is an isometric view of modules 7 and 8 illustrated in one embodiment of the invention.

Figure 26 is an isometric view of modules 4 and 9 illustrated in one embodiment of the invention.

Figure 27 is an isometric view of modules 3 and 9 illustrated in one embodiment of the invention, while module 9 is located on top of module 3.

Figure 28 is an isometric view of modules 1 and 7 illustrated in one embodiment of the invention.

Figure 29 is an isometric view module 1 mounted on a truck bed illustrated in one embodiment of the invention.

Figure 30 is a schematic side view of module 10 - a heat exchanger of a compact Evaporator positioned on truck illustrated in one embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

KemeX has developed a new SAGD plant design that achieves the following:

- a) Plant capacity and size reduced to fit business needs and improves economics
- b) Lower capital and operating costs per unit of production
- c) Increased plant reliability
- d) Reduced environmental footprint
- e) Extended facility life through portability

Key Design Features and Benefits

The plant design that was created focused on addressing the critical factors influencing future oil sands exploitation needs. Key features of the KemeX 1ⁿ Site/UltraLite SAGD plant design include:

- Modular / Portable design
- Lower capital cost
- Lower operating costs
- Smaller capacity
- Lower environmental impact
 - Higher water recycle rate
 - High energy efficiency
 - Lower emissions
 - Minimal land disturbance
- Shorter project schedule

Modular / Portable

The modular / portable concept provides some distinct advantages:

- Minimizes the site labour requirement, thus significantly reducing cost and schedule risk with a large work force working in a remote location under adverse weather conditions.
- Provides flexibility to relocate the facility once the resource in a particular location has been exploited or proves uneconomic.
- A single pilot plant can be used across a number of sites.
- Site reclamation easily and cheaply accomplished.

Lower Capital Costs

Capital cost reductions in the range of 30% to 40% compared to conventional SAGD designs are achieved through the following:

- Integration of well pads and process plant on a single site (minimal interconnecting pipelines required).

- Process simplification and streamlining incorporated into the design to reduce or eliminate redundant or unnecessary equipment.
- Standard equipment available from numerous vendors utilized rather than large, expensive, custom designs for oil sands applications that are available from limited number of vendors.
- Modular and portable concept minimizes on-site construction (lower labour rates, higher productivity and no large construction camp and office facilities).
- Compact design with direct module-to-module connections with pipe racks integral to the module structure minimize the need for external pipe racks.
- Small scale eliminates the need for sulphur recovery.

Lower Operating Costs

Operating cost savings in the 5% to 10% range are achieved through the following:

- Process automation reduces on-site and maintenance staff while also improving reliability and sustainability of maximum operating rates (reduce fixed cost per bbl).
- Energy efficiency through heat integration, elimination of unnecessary recycles and selection of optimum process conditions. Efficiency exceeds conventional design by 5%.
- Onsite power generation to reduce electrical power costs. Heat recovery from power generation produces additional steam for oil recovery (highly efficient).
- Minimal indirect costs associated with large camps, road maintenance, and separate pad operation.
- Replace versus repair maintenance strategy at the site with offsite maintenance contractor. Common spares for multiple facilities reduces warehouse spare costs.

Small Scale Processing Plant

Conventional SAGD plants have steadily increased in capacity in an effort to capture economy of scale savings, but at the cost of rendering smaller pods of oil sands uneconomical. KemeX examined plant capacity options that would be better suited to the future needs of oil sands development.

The industry has recognized that cost savings can be achieved by drilling multiple SAGD well pairs (typically 6-10) from a single well pad. It became evident that a plant capacity that matched this well pad output would be an ideal solution for commercial production.

The second application identified was as a substitute for a pilot plant that most companies are installing before proceeding to commercial production. The capital cost for pilot plants is extremely high and are not economically viable. However, proceeding to a commercial scale project without removing the resource risk is unacceptable for many companies. A solution that reduced the cost to conduct a pilot test of the resource was another application ideally suited to the KemeX technology.

These two capacity configurations can be deployed independently or as part of a phased implementation strategy.

1ⁿ Site Model

This configuration is sized for the productive capacity (7,200 bpd) of a single well pad (typically 6-10 SAGD well pairs) and is intended as the “commercial production” model, which is readily scalable as multiple pads are developed. The main processing facility fits on an approximately 125 foot by 125 foot plot space. Modules (24 feet wide by 24 feet high by 100+ feet long) are sized to be transported within the “High Load Corridor” in Alberta.

UltraLite Model

This configuration is sized for productive capacity of one to two well pairs (1,200 bpd). This is the “exploration” model that provides the owner with a reusable/movable pilot plant that can be incorporated into a much more comprehensive exploration program, before committing the significant capital needed for full commercial production. The UltraLite unit is fully functional and economically viable for commercial production on its own. Modules are sized to be transported on most roadways using conventional tractor trailers.

Lower Environmental Impact

The modular / portable SAGD concept dramatically improves key environmental performance parameters.

- High water recycle associated with using evaporators and package boilers allow recycle of greater than 95% of the produced water. This translates to minimal make-up water requirement, which is becoming a significant challenge as the oil sands industry expands to meet demand. For the UltraLite configuration, our design presents a pilot plant option that incorporates similar produced water recycle rates as

opposed to conventional pilot plants that are being approved, but do not recycle any produced water. Due to this fact, most current pilot plants will actually require more make-up water and dispose of more waste water than the commercial scale facility that will follow.

- High energy efficiency ensures minimal greenhouse gas production and efficient use of available hydrocarbon resource.
- Attention has been give to minimize water, air and soil emissions from the SAGD facility.
 - ⇒ Water emissions from an evaporator are less than half of those from a conventional hot / warm lime softener and OTSG system. Further, by generating 100% quality steam, our design does not require blowdown ponds for start-up of the generators.
 - ⇒ Air emissions are minimized through energy efficiency (discussed above) and elimination of steam vents. In our design, steam vents from the process are routed to the evaporator system and the plant can recycle steam from the boiler steam drum to a “dump condenser” whereby the steam is condensed and recycled during plant start-up.
 - ⇒ Soil contamination is minimized by reducing the overall land disturbance area and elimination of process ponds at site. Further, secondary containment is built into each module and tertiary containment of the main process plant will be provided by the concrete pad on which the plant sits..
- Land disturbance for our SAGD facility is much less that other oil sands recovery methods and is actually less than conventional oil on a per unit of production basis. Our plant and well pad on same lease size as a conventional well pad and has eliminated or minimized process ponds, interconnecting pipelines and roads. By moving the majority of construction to urban centers, we have virtually eliminated the need for massive infrastructure such as large construction camps, airports and roads.

Short Project Schedule

The modular / portable SAGD plant can reduce the overall project by one to two years. By shifting the majority of the construction to an off-site module fabrication shop, the site construction is much less and can be undertaken in parallel with the module construction without interference. Further, once the designs are finalized, the engineering work can be reused to immediately start procurement and fabrication of the next plant. This can take 6 months to a year off of the schedule.

This section provides an overview description for the various systems in the modular processing facility. The description is written to accompany the attached figures and attached process sketches. The reader is referred to the KemeX other prior filed provisional United States patent applications (which are incorporated herein by reference) covering:

- a) A SAGD System Utilizing a Flash Drum (Application no. 61376300)
- b) A Water Evaporator for a Steam Assisted Gravity Drainage (SAGD) Processing Facility (PF) System (Application no. 61376301)
- c) A Vapour Recovery Unit for a Steam Assisted Gravity Drainage (SAGD) System (Application no. 61376298)
- d) A Compact evaporator with an external compressor suction drum (Application no. 61436723)

For areas not specifically mentioned in the above listed patent applications, the description includes a typical KemeX design. For areas outside of the above patents, the modular design is meant to encompass process design variations that are well known to someone versed in the prior art.

Production Fluids Treatment

Production fluids are received from the well pads and the first step in the process is to disengage gases (steam, light hydrocarbons) from the liquid phase. The degassed production liquids are cooled by cross exchange with boiler feed water (BFW) in the Inlet Coolers. A separate inlet cooler utilizing glycol is also installed and used for trim cooling or for the full service cooling when the BFW coolers are out of service for maintenance. The outlet temperature is typically controlled at 120-125°C, which is optimum for gravity separation and loss of light hydrocarbon components to the fuel system.

Recycle streams as well as demulsifier and reverse demulsifier are combined with the produced liquids stream upstream of the desand and free water knock-out vessels. In the Ultralite configuration, the combined stream enters a single vessel containing a desand volume, the Free Water Knock-out (FWKO), and the treater. In the 1ⁿ site configuration, the Desand vessel can be either combined with the FWKO/Treater in a single vessel, or be a separate vessel. Conventional designs do not provide a dedicated desand vessel upstream of the FWKO (Fig 1). Any sand present in the production fluids drop out in the Free Water Knockout and is flushed to

downstream equipment. In our design, sand is collected in a Desand Section and periodically cleaned.

There will be a weir between the Desand and FWKO sections to collect the sand with the oil/water interface controlled above this weir. Oil/water separation takes place in both the Desand and FWKO sections and water is drawn from the bottom of the FWKO portion of the vessel. Dilbit and the remaining water from the FWKO section spill over a second weir to the Treater portion of the vessel. Produced water drawn from the FWKO and Treater are combined and flow to the Produced Water De-Oiling System.

In a conventional design, the water draws from the FWKO and the Treater are combined and the total stream is cooled in a common set of exchangers and sent for further treatment (Fig 4). Frequently it is the small (1-3% of the total produced water) water stream from the treaters that goes off specification as operators tend to focus on meeting the oil specification (typically < 0.5% water) at the expense of water quality from this vessel. The result is that the large volume of clean water stream from the FWKO becomes contaminated with the small dirty stream from the Treater, which may not be easily treated downstream. In the proposed design, the intent is to ensure that only on-spec water streams are routed for downstream processing and offending streams are segregated from the process and sent for separate treatment or disposal (Fig 5). The quality of water from both the FWKO and the Treater is monitored via on-line analyzers, and only if the water quality is acceptable are the streams mixed for processing. If the quality of water from either stream is unacceptable, only the unacceptable stream of water is diverted into an off-spec water system for clean-up, leaving the remainder of clean water directed to the normal water clean-up systems.

Maintaining on-spec feed to downstream treating systems will result in better performance and reduced fouling (improved reliability) for the downstream equipment. In addition, early detection and segregation of off-spec water will minimize the volumes that need to be further treated or disposed of offsite (and consequential increase in make-up water).

In a conventional FWKO/Treater design, an emulsion layer typically collects at the interface between the oil and water (Figure 4) as its density falls between that of a pure oil phase and a pure water phase. In current plants, this emulsion or “rag layer” will accumulate at the interface until operations manually initiates a draw of fluid from just below the interface level. The proposed design has continuously monitoring system for this accumulation and a constant small

volume draw from just below the oil / water interface to prevent accumulation of a rag layer (Figure 5 and Figure 10).

Monitoring for buildup of a rag layer will be accomplished using a series of vertically aligned pressure differential taps along the side of both the FWKO and Treater. The variations in differential pressures from these taps will be impacted by the density of the fluid between the taps. This series of differential pressures will be automatically analyzed to infer both the location and the quality of the interface level between the oil and water. A clean interface should show a sharp change in density on a single differential pressure transmitter and relatively constant differential pressures being indicated above and below this point. As the rag layer accumulates, there will be a gradual drift in the differential pressures from that of the clean oil to that of the clean water phase.

To prevent accumulation of a rag layer, a continuous small flow will be withdrawn from both the FWKO and Treater sections just below the controlled interface levels. This stream is cooled and sent to the off-spec treating system or waste disposal storage.

The Dilbit product stream from the treater is cooled and sent to product storage and shipping.

The FWKO / Treater system achieves the bulk oil water separation step. The produced water from these units requires further processing to remove trace quantities of free oil and is achieved in an Induced Gas Floatation Unit (IGF), which is operated just above atmospheric pressure. The IGF feed requires cooling to prevent flashing and boiling in the IGF. The conventional SAGD plant designs incorporate shell and tube heat exchangers to cool the produced water, then route the water through an atmospheric Skim Tank as a final bulk oil removal step, and finally transfer water from the Skim Tank to the IGF (Fig 6). The conventional produced water exchangers have proven to be an extreme fouling service with the exchangers requiring cleaning on as frequent as weekly. Further, if the exchangers fail to cool the produced water below its saturation point, the hot water flashes in the Skim Tank potentially causing an environmental release or in extreme events damaging the tank. To provide a safety margin, the water is typically cooled well below its boiling point to around 80-90 deg C. The Skim Tank is also then used as a collection point for various recycle streams such that the water entering the Skim Tank from the FWKO/Treater is often cleaner than the water leaving the Skim Tank and going to the IGF.

The proposed design utilizes a flash drum to cool the produced water rather than an exchanger (Figure 7). By dropping the pressure to slightly below atmospheric, the water flashes, with the liquid stream leaving the flash drum cooled to just below the boiling point of water. The vapours from the flash drum (which is mostly steam), is condensed in a glycol exchanger with the condensed liquids joining the liquids from the flash drum. This system easily controls cooling temperature at approximately 97 °C by maintaining flash pressure at or below atmospheric and without the dependence on a functioning glycol cooling system. This eliminates the need for an operating margin and the combined liquid stream going forward will be hotter which is better from an energy efficiency and capital cost perspective. Further, this system eliminates direct cooling of the produced water which can foul heat transfer surfaces. The duty is transferred from cooling a fouling liquid to essentially condensing steam which is non-fouling.

The use of a flash drum in a SAGD process is covered in KemeX United States Provisional Patent Application no. 61376300.

The second change in the proposed design is the elimination of the Skim Tank, with our produced water flowing directly from the Flash Drum to the IGF. This ensures the quality of water from the Flash drum is the quality of water entering the IGF, and allows a higher feed temperature entering the IGF which should improve its ability to separate oil and water.

The IGF outlet stream contains a low concentration of oil and suspended solids. The water stream is sent to the Water Treatment system.

Water Treatment

In our process, Mechanical Vapour Compression (MVC) Evaporators are utilized, which can be the patented design developed by KemeX or those designs available on the market.

The Water Treatment System is designed to process a feedwater stream containing dissolved solids and produce a distilled water product of sufficient quality to be used as feed to a conventional package boiler. Changes to a standard evaporator design have been covered under the KemeX United States Provisional Patent Applications no 61376301 and 61436723).

The proposed configuration of this system is a Mechanical Vapour Compression (MVC) Evaporator system versus the alternate hot lime softener / sand filter / weak acid cation (WAC) exchange system. In MVC Evaporators, feed water flows to the evaporator sump and is re-

circulated through the tube side of a falling film heat exchanger. A small portion of the water will evaporate. A compressor increases the pressure and temperature of the vapor and sends it to the shell side of the falling film heat exchanger. Heat exchanged between the vapor and water acts to condense the vapor on the shell side to distilled water and evaporates a small portion of the brine circulation on the tube side. The vapor from the distilled water is separated in a distillate tank, while the distillate is pumped to the downstream consumers.

In our design, produced water is transferred from the IGF outlet to the evaporator via a set of pumps. Various chemicals are added to the evaporator feed water. Feed water is introduced into the Evaporator sump and concentrated brine is removed from the sump for additional treatment or offsite disposal.

Brine Circulation Pumps circulate brine from the Evaporator sump to the top of the tube side of the Evaporator falling film heat exchanger bundle. Brine flows through the tube side of the Evaporator exchanger as a falling film where a small mass fraction is evaporated.

Steam that evolves in the exchanger is disengaged in the sump and routed to the Evaporator Vapour Compressor, which increases the temperature and pressure. The compressed steam condenses on the shell side of the Evaporator exchanger, which causes a similar volume of water to be vaporized from the circulating brine on the tube side of the exchanger. The condensed steam (distillate) from the shell side of the Evaporator exchanger is drained by gravity to the Distillate Tank. The throughput of the Evaporator Vapour Compressor determines the amount of distillate produced. Distillate is sent from the Distillate Tank to the HP BFW Pumps by the Distillate Product Pumps.

The present invention provides evaporator with several variants of heat exchangers arrangements. The first embodiment includes an evaporator with a single heat exchanger Figure 23A. The second embodiment includes an evaporator with two heat exchangers Figure 23. In the second embodiment, there are several ways the heat exchangers can be used.

Two heat exchangers can be connected in parallel while receiving the liquid from the same sump. Alternatively the heat exchangers can be connected in-line, while the discharge of the first sump is transferred into the sump of the second heat exchanger, whereby the concentration of the impurities in the sumps of second heat exchanger being higher compared to the concentration in the first heat exchanger. In both arrangements, two heat exchangers can work simultaneously or

separately while the second heat exchanger can be used as a replacement during shut down and maintenance procedures of the first heat exchanger.

The proposed evaporator design differs from the standard design in four fundamental ways. The first way, covered under the KemeX United States Provisional Patent Application no 61376301, is the method of blowing down the concentrated brine. In the conventional design, a slipstream from the Brine Circulation Pumps is drawn off. This minimizes the equipment required and provides a means of controlling the brine concentration. However, because the feed water to the evaporator contains small amounts of oil, the oil will accumulate at the top of the water in the evaporator sump eventually causing foaming and fouling in the evaporator. In some cases a manual oil skim nozzle is provided just below the expected liquid level, but this will require manual operator intervention and unless sump level is tightly controlled just above the skim nozzle, oil accumulation will occur. The proposed design includes an overflow weir into a brine disposal sump, which would be added to a third party evaporator. The weir will include a v-notch so that the main evaporator sump level can have some variance without flooding or starving the brine disposal sump. With the brine overflowing into the sump, it will carry with it any separated oil before it can accumulate in the sump. The brine blowdown with the oil will be taken off the brine disposal sump via a dedicated set of blowdown pumps for further treatment or disposal. Hence, the oil will be removed automatically and continuously, thus minimizing the foaming and fouling of the evaporator.

The second change, also covered under the KemeX United States Provisional Patent Application no 61376301, involves the control of the evaporator. The main difference here is the proposed design will measure the calcium hardness and silica concentration in the feed, calculate the saturation levels in the sump, and adjust the blowdown and the caustic addition to ensure the proper operation of the evaporator without calcium hardness or silica precipitation. The conventional design is to set the ratio of feed rate to blowdown rate (cycles of concentration) on an assumed hardness concentration in the feedwater. Independently the feedwater pH is controlled by adding to achieve a target pH. However, the real objective is to control the sump pH, which is significantly different than the pH of the feedwater due to the removal of distilled water from the brine and can vary with changes to the cycles of concentration. The practice is to set up the control system based on the worst case inlet conditions, with no adjustments to setpoints to reflect actual inlet conditions. This results in higher blowdown rates (higher disposal costs, higher water make-up rates), and higher caustic usage (and subsequent acid usage during subsequent treatment) than necessary.

The third change is the use of the Produced Water Tank and Boiler Feed Water Tank. In the conventional design, water going to the evaporator flows through the Produced Water Tank and water leaving the evaporator flows through the Boiler Feed Water Tank (Figure 1). In both cases, the intent is to provide direct surge capacity such that a difference in flow entering or leaving the evaporator does not require an immediate change in the evaporator operation. However, since both tanks are atmospheric tanks, it also means the water entering and leaving the evaporator must be cooled below the boiling point of water to ensure the water doesn't flash in the tanks causing and then must immediately be reheated when withdrawn from either tank. Produced Water Coolers are typically designed to cool the produced water from the FWKO / Treaters from 125°C to 80°C prior to entering the Produced Water Tank and then immediately reheated to 100°C for introduction in the warm lime softener or evaporator. Similarly for the Boiler Feedwater Tank, treated boiler feedwater is cooled from just over 100°C to 80°C prior to entering the tank only to be reheated prior to introduction into the boiler (Figure 11). This practice requires additional exchangers, unnecessarily loads up the cooling glycol system and creates points that can accumulate oil in a water system.

In the proposed design, the Produced Water Tank and Boiler Feed Water Tanks are used as available inventory to be accessed only during upset conditions. The general philosophy will be to operate with a low inventory in the Produced Water Tank and a high level in the Boiler Feed Water Tank. However, in the case of an upset in the evaporator system, produced water would be routed to the Produced Water Tank and BFW would be withdrawn from the Boiler Feed Water Tank to allow production to continue a few hours while trying to restore the system back to service.

The fourth change is to the Production Treating and Water treatment systems. The conventional design has Oil Removal Filters (ORF) located after the IGF and before the water treating system, whether it be a hot / warm lime softener or evaporator (Figure 1). These filters are intended to provide final trim oil removal prior to routing to the water treating system. The system is required as the current water treating designs are not equipped to handle above 30 ppm free oil. The ORF's consists of 2x100% or 3 x50% units, generally filled with walnut/pecan shells, with each unit cleaned by backwashing with clean or filtered water every 24 hours, with backwash stream recycle back to the FWKO. While the total volume of water required for backwash is not excessive (less than 5% of total feed water), the instantaneous flow of backwash required is roughly equal to the design flow of the unit. Hence, in order to minimize the impact of the

backwash recycle, storage capacity must be provided for both backwash water supply and backwash recycle and additional controls are required to level out the water flows through the unit..

There are no ORFs In the proposed design (Figure 2 and 3). The rationale for eliminating them are:

1. Better control and monitoring of water quality from the FWKO, Treaters and IGF.
2. The continuous oil skim from the evaporator provides a higher tolerance for oil contamination in the evaporator feed.
3. The ORFs provide little capacity for large oil excursions and are high maintenance, which results in high cost and excessive recycling of water.,
4. Backwashing bitumen from the ORF media with water is very inefficient and in gross excursions, the bed becomes plugged and must be changed out.

In a preferred embodiment of the invention the mobile modular system also has the following equipment:

- A vapour recovery process unit for a SAGD system for a heavy oil recovery facility. The process providing a venturi ejector having one active inlet, one passive inlet and one outlet. The active inlet being supplied with natural gas to provide the gas flow sufficient to operate the ejector, the passive inlet being connected to a mixture of vented vapours from storage tanks and low pressure equipment. And the outlet supplying fuel to a system along with the natural gas. wherein the movement of the natural gas through the ejector creates a vacuum so as to draw the vapours from the tanks and low pressure equipment into the ejector and then toward the low pressure fuel system, wherein the vented vapours are burned, instead of being released to the atmosphere. The use of this equipment is fully disclosed in provisional US Patent Application 61376298 and incorporated herein by reference.
- A water recovery process comprising a flash drum, a flush drum condenser and the final water treating equipment, wherein the hot water produced is introduced into the flash drum, and separated into the cooled liquid and a vapour; the vapour being further cooled in the flush drum condenser, the condensed liquids from the exchanger is mixed with the cooled liquid, this mixture being transferred into the final water

treating unit in which the impurities are removed from the water and the cleaned water transferred to the rest of the process or to atmospheric tanks for storage. The use of this equipment is fully disclosed in United States Provisional Application 61376300 and incorporated herein by reference.

- A water purification process in a SAGD, the process comprising an evaporator, an oil skim weir and a set of controllers. The evaporator having a bottom with a sump provided at the bottom thereof and including an oil skimming weir dividing the sump into a main sump and a blowdown sump, while the water containing impurities flows over the weir from the main sump to the blowdown sump.

In a normal operating mode, the evaporator receiving water from the process and discharging distilled water from a distillate tank and discharging waste brine from the blowdown sump. The system also having a set of controllers including: a distilled water flow meter provided at the discharge of evaporator, a blowdown flow meter measuring the flow from the main sump to the blowdown sump, and a cycle calculator for calculating the ratio between the distilled water flow and blowdown flow and a total flow controller. The cycle calculator provides a set point to the total flow controller, thus the flow of the water into the evaporator does not directly depend on the level of the liquid in the main sump. This way, the operation of the evaporator functions in a contained closed loop environment. The use of this equipment is fully disclosed in United States Provisional Application 61374301 incorporated herein by reference.

- A steam generation and power generation process. Similar to the Evaporator Package, the Steam Generation System consists of conventional boiler technology producing 100% quality steam, which has recently started to gain acceptance in the SAGD industry. The high quality distillate from the evaporator has allowed this shift, whereas conventional SAGD plants employ once through steam generators which are limited to the maximum of 75-80% quality (percent of the boiler feed that is vaporized).

Distillate from the Evaporator Package is fed to the Steam Generation System by the Distillate Product Pumps. Chemicals (oxygen scavenger, dispersant, and neutralizing amine) are added. The high pressure pumps transfer the Boiler Feed water through

the Inlet Coolers, where heat is recovered from the production fluids, and then to the Package Boiler. The Boiler produces superheated steam. The Boiler blowdown is sent to the Produced Water Flash Drum in the Produced Water De-Oiling system. Recycling this stream reduces the amount of makeup water required.

There are other fundamental differences between the proposed design and conventional SAGD design. The first is the steam pressure. Conventional SAGD facilities are designed to produce steam in the 6,000-12,000 kPa pressure range. Although most oil sands in the Athabasca region operate at a reservoir pressure of only 2,000-3,500 kPa, the high steam pressure is rationalized to deliver steam to distant pads at some point in the future.

By locating the SAGD plant close to the wells, the proposed design can utilize standard boiler pressures (4,200 kPa). This is more energy efficient and the lower pressure reduces boiler and piping costs.

Second, the standard OTSG can only produce saturated steam, with some steam condensing due to heat losses as it is transported to and into the well. The proposed design superheats the steam. The heat losses in the steam in the transportation to the well removes the superheat rather than condensing the steam, and hence the full production of steam is provided to the well. The steam is superheated in the boiler and then desuperheated, which provides the capability to control the amount of superheat required to prevent condensation during transfer to the wellhead.

The third change is the design and use of the Produced Gas Cooler as a dump condenser during start-up or standby operation (Figure 8). During normal operation, the Produced Gas Cooler is used to cool the produced gas from the wells, produced gases from the Inlet Separator along with vent gases from the Desand Vessel/FWKO/Treater. The resulting liquids are routed to the Produced Water Flash Drum for treatment in Produced Water Deoiling. The non-condensable gases are sent to the Mixed Fuel Gas Separator in the Fuel Gas System.

Using the Produced Gas Cooler as a steam dump condenser is a temporary operating mode where there is not production coming from the wells, but the boiler is operating with none or only part of the steam being routed to the wells. Some or all of the produced steam is recycled by routing through the Produced Gas Coolers and the condensate is then recycled back to the BFW Tank.

This mode provides the following advantages:

By using the Dump Condenser mode, the boiler can be operated smoothly from 0-100% of capacity. On initial plant start-up, the boiler needs to operate below minimum fire for an extended period. In a conventional design, this requires the boiler to be run at minimum fire, any excess steam vented, and correspondingly additional make-up water is required. This adds pressure during start-up to quickly ramp up rates to at least the boiler minimum fire rate, even if this is not the optimal start-up sequence. With the proposed design, any excess steam up to minimum fire of the boiler will be condensed and the water recovered for reuse. Not only does this save water, it also allows the start-up sequence to be optimized for long term operability of the well and facility rather than minimization of steam venting and water loss.

When the plant is not processing production fluids and heat is not being recovered from the process, the Dump Condenser will use steam to maintain the hot glycol supply temperature to prevent freezing in processing equipment.

In the event of an upset in another area of the plant, the Boiler can be brought to a stable operating point without needing to trip the Boiler. Because the steam is condensed and recycled back to the BFW Tank, the Boiler can be operated in this mode indefinitely and can be quickly brought back into normal service.

Three-way valves are used to line up the feed to and liquids from the Dump Condenser in the different operating modes.

Vapour Recovery Systems

In a conventional plant, the Vapour Recovery System is a distinct utility system (Figure 9). It uses a small liquid ring compressor to compress the low pressure vent gases from various locations and tanks in the process so that the gases can be sent into the fuel gas system for disposal. The reliability of these systems is typically very poor due to the wide range of capacities that the system must be designed for.

In the proposed design, the vapour recovery system is tied into the process in a couple of ways (Figure 9). First, rather than using a liquid ring compressor, the design takes advantage of the high inlet natural gas pressure versus the pressure it is used at. An eductor is used utilizing the high pressure natural gas as motive fluid, the low pressure fuel gas header as the sink, and drawing a vacuum to collect the low pressure gases. In addition to the normal tank vents from the process, the eductor is also used to provide the vacuum required for the flash drum. With no

rotating or moving parts, the reliability of the eductor is high, and the capacity is limited primarily by the amount of natural gas used as the motive fluid, which is normally is large excess over what is required for a a SAGD facility. With the operation of the flash drum and hence the whole water de-oiling process requiring the vacuum, the higher reliability of the eductor vapour recovery system is important to this design.

This eductor design is discussed in previously filed KemeX United States Provisional Patent Application no. 61/376,298 incorporated herein by reference.

There are additional embodiments and benefits of the current invention listed below:

Lower Capital and Operation Costs

Capital and operating costs are a formidable barrier to economic in situ recovery of oil sands. Reducing costs was essential in our design. The concept of reducing the size of the processing plant at the same time made this a significant challenge. However, the disproportionate increase in indirect costs (construction camps, airports, roads, interconnecting pipelines, well pad facilities, cost of capital) as plant size increased led us to realization that economy-of-scale savings could actually be achieved by reducing the scale.

Capital cost savings were essential if we wanted to remain competitive at a reduced plant size. Our design achieves a 30% to 40% reduction in unitized capital costs over the conventional large-scale SAGD currently in development or operation. This reduction is achieved, despite the plant being smaller, through the following:

- Integration of well pads and process plant on a single site.
- Elimination of costs associated with interconnecting pipelines and roadways
- Reduction of scope of well pad facilities through elimination of some process equipment (Group Separator, transfer pumps) and utilities (instrument air, natural gas)
- Process Modifications to the main processing plant:
 - a) Reduce or eliminate redundant or unnecessary equipment such oil removal filters (ORFs), produced water coolers, skim tank and skim oil tank.,
 - b) New or redesigned process equipment to suit oil sands service (evaporator design, flash drum and steam condenser, vapour recovery unit (VRU) eductor,
 - c) Streamlining the process,

- d) Eliminate sequential cooling/heating exchangers when water is routed through water storage tanks,
- e) Generate 100% steam at reduced pressure (match to reservoir and no need for additional pressure to allow for losses during transfer to distant well pads),
- f) Eliminate or reduced of recycle streams, thus reducing the size of equipment,
- g) Standardized equipment that is available from numerous vendors is utilized rather than large, expensive, custom designs for oil sands applications that are available from limited number of vendors,
- h) Package boilers rather than once-through steam generators (OTSGs),
- i) Common pump and heat exchanger configurations where practical,
- j) Water treatment uses mechanical vapour compression evaporators rather than large hot or warm lime softening systems,
- k) Modular and portable concept deployed to achieve the following:
 - o Reduces overall schedule and resulting cost of capital. The faster schedule is achievable by executing parallel activities for: site development, drilling, module design and fabrication, and regulatory approval (18 months for 1ⁿ Site vs 36 months for conventional plants).
 - o Minimizes on-site construction (lower labour rates, higher productivity and no large construction camp and office facilities) and. What has typically been 1-3 years of onsite construction has been reduced to a couple of months of primarily module assembly.
 - o Compact design with direct module-to-module connections that eliminate most of pipe racks, site development and foundation works.
- l) Small scale eliminates the need for sulfur recovery.

KemeX has been able to reduce operating costs by 5% to 10% compared to conventional large-scale SAGD facilities currently in design or operation. These reductions are achieved through the following:

- Process automation is used extensively to achieve increased reliability, leading to reduced operating and maintenance costs.
- More rigorously designed supervisory control (equipment selection, installation, instrumentation type and redundancy)
- Advanced control applications layered above supervisory control applications. Examples include water balance control to proactively control the balance between

steam sent to the wells and the produced water treated from the wells, and controls directing water to and from the Produce Water Tank and Boiler Feed Water Tank.

- Well design alarm and safety integrity system to manage upset conditions with minimal operator intervention
- Energy efficiency exceeds conventional design by ~5%. This improvement is a result of:
 - Heat integration to recover maximum heat from process streams, thus reducing utility heating requirements
 - Reduction in recycle streams
 - Optimum process conditions selected for plant design
 - Steam pressure matched to reservoir conditions, not future transport needs
 - FWKO/treater pressure to reduce diluent losses to fuel system
 - Onsite power generation is incorporated to further reduce operating costs and dependence on third party electrical power supply.
 - Electrical power costs are lower to generate than purchase, even considering cost of capital
 - Heat recovery from power generation produces additional steam for oil recovery (highly efficient cogeneration)
 - Minimal indirect operating and maintenance costs associated with large camps, road maintenance, and separate pad operation
 - Replace vs. Repair at the site with offsite maintenance contractor. Common spares for multiple facilities reduces warehouse spare cost

Increased Plant Reliability

One of the greatest concerns plaguing existing SAGD operations is plant reliability. This is extremely costly in terms on lost production, operating and maintenance costs and risk of damage to equipment, personnel or the environment. Improving plant reliability became a critical element of our design in order to reduce operating and maintenance costs in line with the reduction in plant capacity. Improvements in reliability resulted from the following design features:

- Increased level of process automation
- Equipment design and selection
- Evaporator internals

- Evaporator design
- Recycle steam condenser
- Free water knockout (FWKO) and desand vessel
- Elimination of high maintenance equipment
 - VRU eductor vs VRU compressor
 - Flash drum/condenser vs. produced water coolers
 - Package boiler vs. OTSG
 - Evaporator vs. hot/warm lime softener
 - No oil removal filters (ORFs), eliminating high maintenance equipment that results in substantial recycle
 - Common types/sizes of equipment for multiple services
 - Replace and repair philosophy vs. on-site maintenance
 - Continuous streamlined process configuration
- Inventory management to allow continued operation during maintenance of specific unit operations
- Start-up and operation in total recycle mode allows a more reliable start-up or suspended operation. Return to full capacity from suspended “total recycle” mode can be facilitated in a quick and controlled manner.

Reduced Environmental Footprint

Increasing International and domestic pressure is making the environment impact of oil sands production as significant issue. Our design improves the environmental footprint in a number of critical aspects.

- Land disturbance
 - Small plant footprint (125' x 125' plot for main processing plant)
 - No need for blowdown ponds normally associated with OTSGs
 - No interconnecting pipelines/roadways to well pads which unnecessarily disrupt large tracts of land and are impediments to natural movement of local wildlife
 - Elimination of large site camp and office facilities
- Water utilization
 - Using evaporators and package boilers minimizes water blowdown to 2-4%, which is several times better than conventional SAGD plants

- Future design enhancements can easily re-use the majority of the water from the blowdown stream
- Energy efficiency (emissions)
 - Increased energy efficiency
 - No atmospheric vents
 - Increased plant reliability
- Site remediation
 - Modular/portable concept minimizes time to remove equipment from an abandoned site
 - No ponds associated with the facility
 - Three levels of containment (process, module and process plant concrete pad)

Extended Plant Life

Modular and Portable: KemeX has extended the widely accepted concept of modular construction to incorporate portability. Our process plant design consists of transportable close-coupled modules that can be assembled or dismantled in 30 days and moved via the existing high-load transport corridor in Alberta. This concept offers a number of distinct advantages as discussed in other sections of this document:

- Minimal On-site Construction (cost, schedule, risk and environmental impact benefits)
- Reduced Capital Cost (see above for details)
- Reduced resource risk since equipment can be redeployed at different sites if resource proves uneconomic or has been fully exploited.

KemeX adopted some unique concepts to efficiently achieve a design that was both modular and portable. These concepts are well suited to SAGD plants and could be extended to other processes.

- All main process modules to be direct coupled to eliminate the need to site constructed pipe racks.
- Piping between modules will be run on pipe racks integral to the modules. Corridors of space reserved on modules to accommodate inter-module and on-module piping, which was necessary to avoid pipe interference when routing within module space

constraints. This system is design to simplify piping and to facilitate the disassembly and reassembly of the modules in a new location.

- In most instances, piping between modules will be connected by flanges rather than by welding.
- Module layout will generally locate equipment to one side of the module, to provide space for personnel access to equipment and instrumentation.
- Frequent maintenance equipment will be moved to the perimeter of the modules to allow easy access for removal and replacement.
- Vapour handling systems located on the second level to minimize safety risks.
- Electrical power is generated within the design to eliminate dependence on purchased power and eliminate the infrastructure required to bring it to the site.
- Transformers, switchgear, and MCCs are installed on a single module to allow all interconnecting wiring to be accomplished off site.
- Power connections, with the exception of continuous cable runs between the MCCs and the actual motors, are terminated at the boundary limits of each module so that the PF power grid may be “plugged together”, thus reducing the need to pull cables to only the aforementioned medium or high voltage connections.
- The control system architecture is based on hardwired I/O modules installed in environmentally hardened enclosures installed on each process module.
- No instrument connections between modules are entertained. All inter-module control connections are to be at the network level in order to reduce the quantity of connections between modules and between the PF and the control building.
- Diluent is brought in by truck and product shipped out by truck to eliminate the need for pipelines to a new site. A natural gas pipeline is still required. The design can be modified depending on the source of makeup water and the availability of deep well disposal for the brine.
- The modules will be test assembled, pressure checked, and commissioned before disassembly and reassembly at the first location. This will help prove out the assembly/reassembly requirements as well as significantly reduce the field fit-up, commissioning cost and schedule length.

It is understood that the pre-assembled modular units when removed from the trailer are positioned at the remote location on prepared foundation / support such as concrete foundation, concrete columns, rock base or any other foundation preparation known in the art. Ultimately the trailer might be adapted with a set of jacks or other means to support the modules in the location

without removing them from the truck. Further the trailer might be a specially designed trailer for transport the module and support the module at the remote location.

As many changes can be made to the preferred embodiment of the invention without departing from the scope thereof; it is intended that all matter contained herein be considered illustrative of the invention and not in a limiting sense.

CLAIMS

1. A transportable modular process for exploiting a remote heavy oil resource or the like using steam assisted gravity drainage technology or the like;
said process comprising transportable preassembled and commissioned modules which when interconnected adjacent said remote heavy oil resource provide the ability to exploit said heavy oil resource or the like; each module being preassembled and commissioned at the time of manufacture with the necessary piping and electrical wiring and other essential equipment for each module prior to being transported to adjacent the resource,
each module being, when transported to adjacent said resource, able to be readily interconnected with other process modules to enable an entire SAGD process or the like to be constructed adjacent said resource,
wherein once said resource is depleted said modular process may be disassembled and transported to a different remote resource, and subsequently reassembled at said different remote resource in the same manner;
wherein said process comprises several transportable modules selected from the following group of modules:

- oil and water separation modules;
- flash cooling of produced water rather than the conventional heat exchanger or the like;
- Vapor Recovery Unit (VRU) Ejector and fuel gas system modules;
- compact evaporator with an external demister or other evaporators available on the market and modified where necessary;
- cooling system modules (for example glycol cooling system);
- boiler feed water storage/supply and chemical addition modules;
- boiler modules;
- power Generation modules;

and once selected, transported, assembled and securely interconnected, providing a complete SAGD process or the like for exploiting said remote resource.

2. A transportable modular system for hydrocarbon extraction using a SAGD Process, said system comprising the following interconnected modules assembled into said process at a desired site, but each module being commissioned where constructed prior to being transported:

- a) module 1 comprising inlet coolers, an inlet separator, a de-sand unit, and Free Water Knock-Out and Oil Treating vessels;

- b) module 2 comprising of an Induced Gas Floatation Unit, distillate tank and Dilbit cooler;
- c) module 3 comprising the evaporator exchanger;
- d) module 4 comprising an evaporator compressor, evaporator recirculation pumps and chemical addition machinery;
- e) module 5 comprising boiler feed water pumps, instrument air systems and electrical systems;
- f) module 6 comprising a boiler;
- g) module 7 comprising power generation and a Heat Recovery Steam Generator;
- h) module 8 comprising a glycol cooler or other cooling system;
- i) module 9 comprising a flash drum, flash drum condenser, and dump condenser;
- j) module 10 comprising a glycol expansion drum, fuel gas drum, and additional heat exchangers;

wherein said modules or the like being assembled and interconnected into said process by the provision of the boundaries of said modules being adapted to be securely connected by mechanical means, and by connecting electrical lines and piping runs extending from module to module.

3. The modular system of claim 1 or 2 wherein said modules are interconnected and once this is done further comprising the necessary piping and tubing, fastening means, electrical lines and sets of controllers required for the operation of the modular process/system.

4. The modular process of claim 1 or 2 wherein at least one of the said modules is selected from the following list of modules:

- a) third party evaporator modified to incorporate KemeX weir and a set of controllers; and/or
- b) compact evaporator with an external compressor suction drum; and/or
- c) VRU Ejectors; and/or;
- d) flash cooling system for produced water as opposed to conventional heat exchanger.

5. A method of transporting a SAGD process or the like to a remote hydrocarbon reservoir comprising:

- defining modules which collectively substantially make up the process when assembled together to substantially form said process including preferably modules 1 to 10 of claim 2,
- constructing said modules adapted to be fitted on a tractor trailer, rail car, barge or the like,
- transporting said modules to the remote location using trucks or other suitable means of transportation,
- assembly of said modules at the remote location into said SAGD process or the like, for extraction of hydrocarbons using the SAGD process at the remote location.

6. A method of constructing a modular transportable SAGD system comprising modules of claim 1 or 2 comprising:

- a) defining modules which when assembled collectively make up the process for extraction of hydrocarbons,
- b) constructing separate interconnecting modules adapted to be transported by a truck or other means of transportation,
- c) commissioning of the system of the modules at the manufacturing location,
- d) disassembling the system into the modules,
- e) preparing the modules for transportation to the remote location.

7. A use of a system of claim 1 or 2 further comprising steps of:

- a) constructing and assembling the modules at a manufacturing location(s) different from the final plant site adjacent the resource;
- b) assembling the system from the modules at the manufacturing location(s);
- c) testing and commissioning the modules and/or the combination of modules at the manufacturing location(s);
- d) disconnecting the modules and positioning them on tractor trailers, rail cars or other suitable means of transportation;
- e) transporting the modules to adjacent the oil sands or heavy oil resource location;
- f) assembling the system from the modules at the remote location;
- g) extracting hydrocarbons from the oil sands or heavy oil deposits using the assembled system;

wherein the system can be disassembled and relocated to another remote location if necessary.

8. A process comprising several modules selected from the following group of modules:
- oil and water separation modules;
 - flash cooling of produced water rather than the conventional heat exchanger or the like;
 - vapor Recovery Unit (VRU) Ejector and fuel gas system modules;
 - compact evaporator with an external demister or other evaporators available on the market and modified where necessary;
 - cooling system modules (for example glycol cooling system);
 - boiler feed water storage/supply and chemical addition modules;
 - boiler modules;
 - power Generation modules;

thus providing a complete SAGD process or the like for exploiting a remote resource.

9. A process for hydrocarbon extraction from a resource, using an SAGD process, said process comprising the following modules:

- a) module 1 comprising inlet coolers, an inlet separator, a de-sand unit, and Free Water Knock-Out and Oil Treating vessels;
- b) module 2 comprising of an Induced Gas Floation Unit, distillate tank and Dilbit cooler;
- c) module 3 comprising an evaporator exchanger;
- d) module 4 comprising an evaporator compressor, evaporator recirculation pumps and chemical addition machinery;
- e) module 5 comprising boiler feed water pumps, instrument air systems and electrical systems;
- f) module 6 comprising a boiler;
- g) module 7 comprising power generation and a Heat Recovery Steam Generator;
- h) module 8 comprising a glycol cooler or other cooling system;
- i) module 9 comprising a flash drum, flash drum condenser, and dump condenser;
- j) module 10 comprising a glycol expansion drum, fuel gas drum, and additional heat exchangers;

wherein said modules or the like being interconnected into said process in order to exploit said hydrocarbon resource.