## Description

The present invention relates to apparatus for conducting and controlling chemical reactions, and more particularly to practical apparatus, wherein various kinds of liquids such as catalysts, solvents and acidic or basic solutions for pH control may be added correctly and automatically when needed whereby proper reaction parameters and reaction speeds may be maintained. In addition, in the apparatus of the invention, excess gases may be automatically removed. The apparatus of the invention has great utility for automatic management of chemical reaction tests in various industrial fields.

As is presently well known, research institutes and laboratories are often called upon to conduct actual experiments and to observe chemical reactions such as condensation and/or polymerization reactions involving chemicals such as polymers or monomers. Often large research institutes are required to perform a large number of chemical experiments simultaneously, and in these experiments dealing with chemical reactions, proper management is an obsolute necessity for all operating conditions such as the proper supply of additive liquids including catalysts, solvents and acidic or basic pH-adjustment solutions, control of reaction kenetics and removal of excess gases evolving from or dissolved in residual acid solutions, and the experiments sometimes might create hazardous situations, such that constant surveillance is required.

In the past, a single person in charge of this kind of experimentation could handle only about three to five sets of experimental apparatus, at best, in view of physical limitations and safety considerations. In order to operate a multiplicity of sets of apparatus at one time, a large number of people have been needed for the management thereof. In view of present economical conditions, personnel expenses have a great influence upon total cost involvement, and therefore it is now desirable to minimise such personnel expenses.

Automated control of batch processes has been proposed previously e.g. in FR-A-2140832 and in the paper by V.C. Lim "small batch reactor control system integration" in the "proceedings of the ISA/88 international conference", but such previous proposals do not go far enough to enable multiple experiments to be left unattended in a research laboratory.

The present invention has as an important objective, the provision of apparatus for conducting and controlling chemical reactions, wherein a large number of individual chemical reaction apparatuses can be managed and controlled by a limited number of persons with an accuracy of surveillance which cannot be realized in the prior art.

The invention has as another object the provision of practical and novel apparatus, wherein various kinds of additive liquids such as catalysts, solvents and acidic or basic pH-adjusting liquids can be added correctly and automatically whenever they are needed.

A further object of the present invention is to provide an apparatus for accurately controlling chemical reactions, wherein removal of excess gases from residual acid solutions can be automatically performed.

The invention has as a further objective, the provision of an apparatus for safely controlling chemical reactions, wherein reaction speed can be maintained and stabilized, and excessive reaction rates are avoided so that the expected results for the chemical reactions can be obtained.

Other objects and features of the invention will become apparent from the description thereof which follows.

In accordance with the invention there is provided an apparatus for conducting and controlling a chemical reaction comprising:

a reaction vessel (1) for receiving and mixing a plurality of liquids for reaction;

a plurality of containers (2, 3 and 4) for holding a supply of additive liquids to said vessel (1);

a like number of pumps ($P_1$, $P_2$ and $P_3$) for transporting said liquid additives from respective containers to said vessel;

a like number of motors ($M_1$ $M_2$ and $M_3$) for driving said pumps under the control of respective speed adjusters (51, 52 and 53);

a plurality of weighing scales (22, 32 and 42) for monitoring the weight of the respective additives in the containers (2, 3 and 4);

a temperature sensor (TS) for outputting a signal corresponding to the temperature of the reaction liquids in said vessel;

liquid level sensors (91, 92) in said vessel for outputting signals corresponding to the liquid level in said vessel;

a cooling jacket (71) surrounding the outer surface of said vessel for cooling the vessel forcibly from outside by receiving cooling fluid from a cooler (7);

a heating tub (81) containing heating fluid preheated to a required temperature, said tub being moveable by an elevator into and out of a heating relationship with the bottom of said vessel, for heating the vessel forcibly when the bottom of the vessel is submerged in the heating fluid and permitting radiation of heat from the vessel when the bottom of the vessel is separated from the heating fluid; and

a CPU (5) connected to receive signals from said temperature sensors, said liquid level sensors, and said weigh scales for monitoring and control-

ling the reaction

characterised in that said CPU (5) is arranged to operate;

(a) when the value of the temperature signal is below a safety range, to elevate the heating tub to immerse the bottom of the vessel in the heating fluid so that a required contact area is heated;

(b) when the value of the temperature signal enters the safety range from below, to lower the heating tub (81) to separate the bottom of the vessel from the heating fluid;

(c) when the value of the temperature signal rises above the safety range, to supply cooling liquid to said cooling jacket;

(d) when the values of the signals from said weighing scales (22, 32, 42) representing the current weight deviate from required values, to output signals corresponding to the deviation to the speed adjusters (51, 52 and 53) to keep the weight of the containers within a given proximity to the required values at a given time; and

(e) when the liquid level sensor (91) produces an upper limit signal, to open a ventilation valve (not shown).

The invention will now be described with reference to the accompanying drawings:

Figure 1 is a block diagram illustrating the components of a general and basic apparatus for conducting and controlling chemical reactions pursuant to the principles and concepts of the present invention; and

Figure 2 is a block diagram illustrating additional components for the apparatus of Figure 1.

Apparatus which embodies the concepts and principles of the invention is illustrated in the drawings. The apparatus includes a reaction vessel (1) for containing reaction liquids and having on its outer circumference a cooling element in the form of a refrigerating jacket (71) into which refrigerant may be supplied. As shown in Figures 1 and 2, the vessel (1) has four cylindrical mouths or openings, (11), (12), (13) and (14).

A pipe (21) communicating with a liquid container (2) containing a catalytic liquid to be added to the liquids in the vessel (1), a pipe (31) communicating with an acidic liquid container (3) containing an acidic liquid to be added to the reaction liquids, and a pipe (41) communicating with a liquid container (4) containing a basic liquid to be added to the reaction liquids, are all arranged so as to project into the vessel (1) through the opening (11). A ceramic pump ($P_1$) driven by a pulse motor ($M_1$) is arranged to move liquid along pipe (21) and into the vessel (1), a ceramic pump ($P_2$) driven by a pulse motor ($M_2$) is arranged to move liquid along the pipe (31) and into the vessel (1), and a ceramic pump ($P_3$) driven by a pulse motor ($M_3$) is arranged to move liquid along the pipe (41) and into the vessel (1). By rotational control of the motors ($M_1$), ($M_2$) and ($M_3$), the required amount of each respective liquid may be supplied to the vessel (1).

The regulation of the flow volume for the additive liquid (catalytic liquid in this case) through the pipe (21) may be conducted as follows. When the pulse motor ($M_1$) is driven, the ceramic pump ($P_1$) starts to move the additive liquid contained in the additive liquid container (2) into the reaction vessel (1), and at that time, the decreasing weight of the liquid in the additive liquid container (2) is constantly detected and monitored by timely measurement with a first electronic scale (22). The scale (22) provides a signal corresponding to the present time detected weight value of liquid in the container (2) and such signal is transferred to a Central Processing Unit (CPU) (5). The CPU (5) compares the signal value outputted by the first electronic scale (22) with a preset standard value and produces a revised signal calling for adjustment of the difference between the two values to zero. The revised signal is transferred into a first speed adjustor (51) having a digital-analog converter circuit and a noise killer circuit, and the revised signal, which has been in the form of a digital signal, is converted by the adjustor (51) into a pulse signal. The pulse signal from the adjustor (51) is inputted into the pulse motor ($M_1$) has instructions to rotate a sufficient number of times to cause the current weight value of the container (2) to become equal to the standard value. In this embodiment, a 16-bit personal computer, No. PC-9801, made by Nihon Electric Company, may be used as the CPU (5).

The flow of the pH adjustment liquids (acidic liquid and basic liquid) through the pipes (31) (41) is controlled and regulated as follows. A pH-sensor (61) having a glass electrode is inserted into the reaction liquids undergoing reaction in the vessel (1) through the opening (14). The sensor (61) measures the electric potential value in proportion to hydrogen ion concentration in the reaction liquids and outputs a present time pH-value signal to be transferred to the CPU (5).

If the present time pH level signal is larger than a preset standard value for the idealistic reaction (a standard value of pH 5 for example), the CPU (5) transfers an acid reaction supply signal to a second speed adjustor (52) so that the difference between the values may be eliminated correctly. The second speed adjustor (52), which obtains the acid reaction supply signal from the CPU (5) converts the digital signal into a pulse signal and inputs the pulse signal in the pulse motor ($M_2$), which drives the ceramic pump ($P_2$) for the required number of rotations. Thus, an appropriate quantity of acidic liquid is drawn up from the acidic liquid container

(3) and moved into the reaction vessel (1) through the pipe (31), resulting in the achievement of the standard pH level in the reaction liquids.

On the other hand, if the present time pH level signal is smaller than the preset standard value, the CPU (5) transfers a basic reaction supply signal to a third speed adjustor (53) so that the difference between the values may be eliminated. The third speed adjustor (53), using a procedure which is the same as the procedure explained above, changes the digital signal into a pulse signal which is inputted into the pulse motor ($M_3$) driving the ceramic pump ($P_3$), whereby basic liquid is drawn up from the basic liquid container (4) and is moved into the reaction vessel (1) via the pipe (41).

The flow volume of the acidic liquid and basic liquid is regulated using second and third electronic scales (32), (42) respectively for proper control, and the weight measurements and signal generations are performed in exactly the same way as in the procedures explained above for the regulation of the flow of the catalytic additive liquid.

Reactive heat generated in the reaction vessel (1) is regulated as follows. The refrigerating jacket (71) is arranged to cover the outer circumference of the reaction vessel (1) and operates to freeze the liquid chemical system contained in the vessel (1) by use of a cooler (7). The cooler (7) may optionally be operated to cool the system to a required operating temperature. A heating tub (81) containing a heating substance is arranged beneath the reaction vessel (1), and by operation of a heater (8), the chemical reaction system contained in the reaction vessel (1) may be heated to a required reaction temperature on demand. The heating tub (81) may be moved up and down with an elevating mechanism in accordance with the arrow signs in Figure 2, although the details of such mechanism are known and are not shown in this specification.

The cooling mechanism, which includes the jacket (71) and the cooler (7), and the heating mechanism, which includes the tub (81) and the heater (8), operate in accordance with temperature stages detected by a temperature sensor (TS) as follows:

1. As long as the temperature of the reaction liquids in the vessel (1) remains within a predetermined safety range, neither the cooling mechanism nor the heating mechanism is called upon to do any work. The safety range as mentioned here includes the temperature zone where the chemical reactions proceed normally and uniformly and in a stable fashion. This zone is prearranged based on values determined empirically.
2. Whenever the temperature of the reaction liquids in the vessel (1) rises above the safety zone yet sill below the dangerous area, the cooling mechanism (7) (71) is operated to lower the temperature back into the safety zone. The dangerous area mentioned here is the temperature area where chemical liquid reaction systems experience extreme reactions such as sudden ebullition, firing and/or explosion. This dangerous area is again predetermined based on values determined empirically to thus prevent unexpected accidents.
3. When the temperature of the reaction liquids in the vessel (1) is below the safety range, the heating tub (81) may be raised so as to bring the heating substance into contact with the reaction vessel (1), and the heater (8) is switched on to heat the container up to the desired reaction temperature.

In order to obtain and maintain the necessary reaction conditions for the reaction liquids contained in the reaction vessel (1), extra gas (for instance, oxygen chlorine and carbonic acid gas) which may interfere with the progress of the chemical reaction, must be removed from the proximity of the liquid system, and such removal may be accomplished using the regulating mechanisms illustrated in Figure 2.

With reference to Figure 2, a vacuum pump (54) is operated so that gases present in the vessel (1) may be evacuated through a degassing pipe (VP) communicating through the cylindrical opening (13). In this situation, the CPU (5) issues a signal consisting of degassing instructions, and when the signal is inputted into a driver (55), the latter converts the degassing signal into a pulse signal. The thus generated pulse signal is supplied to a pulse motor (PM) to initiate the rotation thereof at the required angular velocity. As the pulse motor (PM) rotates, a flow regulating valve (56) arranged in the degassing pipe (55) opens to facilitate evacuation of the reaction vessel (1) at the instructed flow rate. When the interior of the reaction vessel (1) becomes evacuated to the required degree, a vacuum sensor (57) detects the pressure situation and issues a signal to deenergize the pulse motor (PM) and close a vacuum cock (58). The CPU (5) then issues a signal consisting of freezing instructions to cause operation of the cooler (7) for cooling the refrigerating jacket (71), to cause the chemical liquid in the vessel (1) to become frozen. When freezing occurs, the temperature sensor (TS) installed in the reaction vessel (1) detects the situation and issues a freezing signal. When the vacuum signal issued by the vacuum sensor (57) and the freezing signal issued by the temperature sensor (TS) are both inputted together, the CPU (5) operates to open a flow regulating valve (59) in an inert gas pipe (NP) to introduce inert gas (nitorogen, for example) at the required flow rate

via a driver (D) into the reaction vessel (1).

When the vessel (1) is filled with inert gas, the CPU (5), in correspondence with the vacuum sensor (57), operates the heater (8) to elevate the temperature in the heating tub (81) so that it is able to thaw the chemical liquid system in the reaction vessel (1). The CPU (5) also operates to open the vacuum cock (58) for repeated degassing by the vacuum pump (54) under the regulation of the flow regulating valve (56).

As explained above, the linked steps of evacuation and refilling with inert gas, freezing of the chemical reaction system liquid, thawing of the liquid, and repeated degassing, all of which contribute to the desired removal of residual gases from the chemical liquid system, reduce obstacles which otherwise would interfere with the progress of the desired reaction. All of these operations may be automatically performed using the reaction apparatus of the invention.

The apparatus of the invention may be used to conduct surveillance of the liquid system in the vessel (1) as follows. As shown in Figures 1 and 2, an upper limit level sensor (91) and a lower limit level sensor (92) may be inserted into the reaction vessel (1) through the cylindrical opening (14). Thus, when the liquid level rises to contact the upper level sensor (91) as a result of the occurrence of bubbles caused by the influence of reactive heat, the sensor (91) is actuated to issue a signal to the level detector (9), and the level detector (9) in turn produces an electric upper limit signal which is transferred to the CPU (5). The CPU (5) then opens a ventilation valve (not shown in the drawings) to restore the pressure in the reaction vessel (1) to normal atmospheric pressure, whereupon overflow of chemical liquid is avoided.

On the other hand, when the liquid level in the vessel (1) drops to the level of the lower limit sensor (92), the latter signals this fact to the level detector (9), and the level detector (9) produces an electric lower limit signal which is transferred to the CPU (5). The CPU (5) then generates and transfers a signal to the first speed adjustor (51) to operate the ceramic pump ($P_1$), whereon catalytic liquid is withdrawn from the container (2) and is supplied to the reaction vessel (1).

The preferred embodiments of this invention have been explained above; however, the invention is not limited to these embodiments alone. Various amendments or changes are available based on the scope as described in this specification or in the claims appended hereto. For instance, a mechanism may be provided for stirring the reaction liquids in the reaction container (1). Such mechanisms may take the form of a stirring propeller (N) driven by the DC motor ($M_5$). The DC motor ($M_5$) may be operated at a constant rotational speed under the influence of a servomechanism (5b) operating via a digital-analog converter (5a). The rotational torque of the DC motor ($M_5$) for constant speed may be calculated by a torque calculator (5c) and transferred to the CPU (5). The rotational speed may be calculated by a rotation calculator (5d) as an analog signal which is also communicated to the CPU (5) after it is converted into a digital signal via an analog-digital converter (5e). Thus, the CPU(5) controls the servomechanism (5b) via the digital-analog converter (5a) so as to operate the DC motor ($M_5$) properly whenever the rotational torque or rotational speed need to be changed to accommodate changes in the viscosity of the reaction liquids in the reaction vessel (1).

As explained in the actual embodiments set forth above, the apparatus provided by this invention accomplishes (1) the automatic and economical management of the proper supply of additive liquids like catalytic liquids or solvents and for pH-control to the liquid reaction system; (2) the removal of excess gases from the proximity of chemical liquids to be reacted; and (3) the stabilization of procedures for chemical reactions through proper restraint of excessive reactions in the reaction liquids. Therefore, the apparatus of the invention is useful for present requirements where a number of chemical experiments should be managed properly and concurrently, and is also useful to rationalise and economise chemical experimentation where in the past a large number of people were needed for managing and watching a variety of experiments.

## Claims

1. Apparatus for conducting and controlling a chemical reaction comprising:

a reaction vessel (1) for receiving and mixing a plurality of liquids for reaction;

a plurality of containers (2, 3 and 4) for holding a supply of additive liquids to said vessel (1);

a like number of pumps ($P_1$, $P_2$ and $P_3$) for transporting said liquid additives from respective containers to said vessel;

a like number of motors ($M_1$ $M_2$ and $M_3$) for driving said pumps under the control of respective speed adjusters (51, 52 and 53);

a plurality of weighing scales (22, 32 and 42) for monitoring the weight of the respective additives in the containers (2, 3 and 4);

a temperature sensor (TS) for outputting a signal corresponding to the temperature of the reaction liquids in said vessel;

liquid level sensors (91, 92) in said vessel for outputting signals corresponding to the liq-

via a driver (D) into the reaction vessel (1).

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a plurality of containers (2, 3 and 4) for holding a supply of additive liquids to said vessel (1);

a like number of pumps ($P_1$, $P_2$ and $P_3$) for transporting said liquid additives from respective containers to said vessel;

a like number of motors ($M_1$ $M_2$ and $M_3$) for driving said pumps under the control of respective speed adjusters (51, 52 and 53);

a plurality of weighing scales (22, 32 and 42) for monitoring the weight of the respective additives in the containers (2, 3 and 4);

a temperature sensor (TS) for outputting a signal corresponding to the temperature of the reaction liquids in said vessel;

liquid level sensors (91, 92) in said vessel for outputting signals corresponding to the liq-

uid level in said vessel;

a cooling jacket (71) surrounding the outer surface of said vessel for cooling the vessel forcibly from outside by receiving cooling fluid from a cooler (7);

a heating tub (81) containing heating fluid preheated to a required temperature, said tub being moveable by an elevator into and out of a heating relationship with the bottom of said vessel, for heating the vessel forcibly when the bottom of the vessel is submerged in the heating fluid and permitting radiation of heat from the vessel when the bottom of the vessel is separated from the heating fluid; and

a CPU (5) connected to receive signals from said temperature sensors, said liquid level sensors, and said weigh scales for monitoring and controlling the reaction

characterised in that said CPU (5) is arranged to operate;

(a) when the value of the temperature signal is below a safety range, to elevate the heating tub to immerse the bottom of the vessel in the heating fluid so that a required contact area is heated;

(b) when the value of the temperature signal enters the safety range from below, to lower the heating tub (81) to separate the bottom of the vessel from the heating fluid;

(c) when the value of the temperature signal rises above the safety range, to supply cooling liquid to said cooling jacket;

(d) when the values of the signals from said weighing scales (22, 32, 42) representing the current weight deviate from required values, to output signals corresponding to the deviation to the speed adjusters (51, 52 and 53) to keep the weight of the containers within a given proximity to the required values at a given time; and

(e) when the liquid level sensor (91) produces an upper limit signal, to open a ventilation valve (not shown).

2. Apparatus as claimed in Claim 1 in which one of said containers (3) is for an acidic liquid and another (4) is for a basic liquid and in which there is provided a pH detector including a sensor in the reaction liquids and generating an electrical signal corresponding to the current pH level of the liquids, said CPU (5) receiving said pH signal and utilizing it in the control of its outputs to the speed adjusters (52, 53) associated with the containers (3, 4) to maintain the pH value at a desired level.

**Patentansprüche**

1. Vorrichtung zum Durchführen und Steuern einer chemischen Reaktion mit:

einem Reaktionsgefäß (1) zum Aufnehmen und Mischen einer Mehrzahl von Flüssigkeiten für eine Reaktion;

einer Mehrzahl von Behältern (2, 3 und 4) zum Halten eines Vorrates von additiven Flüssigkeiten für das Gefäß (1);

einer gleichen Zahl von Pumpen ($P_1$, $P_2$ un d $P_3$) zum Transportieren der flüssigen Zusatzstoffe von entsprechenden Behältern zu dem Gefäß;

einer gleichen Zahl von Motoren ($M_1$, $M_2$ und $M_3$) zum Antreiben der Pumpen unter der Steuerung entsprechend der Geschwindigkeitseinsteller (51, 52 und 53);

einer Mehrzahl von Waagen (22, 32 und 42) zum Überwachen des Gewichtes der entsprechenden Zusatzstoffe in den Behältern (2, 3 und 4);

einem Temperatursensor (TS) zum Ausgeben eines Signales, das der Temperatur der Reaktionsflüssigkeiten in dem Gefäß entspricht;

Flüssigkeitspegelsensoren (91, 92) in dem Gefäß zum Ausgeben von Signalen, die dem Flüssigkeitspegel in dem Gefäß entsprechen;

einem Kühlmantel (71), der die äußere Oberfläche des Gefäßes umgibt, zum zwangsweisen Kühlen des Gefäßes von außen durch Aufnahme von Kühlflüssigkeit von einem Kühler (7);

einer Heizwanne (81), die ein auf eine gewünschte Temperatur vorgeheiztes Heizfluid enthält, wobei die Wanne durch eine Hebevorrichtung in eine heizende Beziehung und aus einer heizenden Beziehung mit dem Boden des Gefäßes bewegbar ist, zum zwangsweisen Heizen des Gefäßes, wenn der Boden des Gefäßes in das Heizfluid getaucht ist, und zum Ermöglichen von Wärmestrahlung von dem Gefäß, wenn der Boden des Gefäßes von dem Heizfluid getrennt ist; und

einer CPU (5), die angeschlossen ist zum Empfangen von Signalen von dem Temperatursensor, den Flüssigkeitspegelsensoren und den Waagen zum Überwachen und Steuern der Reaktion;

dadurch gekennzeichnet,

daß CPU (5) so ausgelegt ist, daß sie tätig ist:

(a) wenn der Wert des Temperatursignales unterhalb eines Sicherheitsbereiches ist, zum Heben der Heizsonne zum Eintauchen des Bodens des Gefäßes so in das Heizfluid, daß eine gewünschte Kontaktfläche geheizt wird;

(b) wenn der Wert des Temperatursignales den Sicherheitsbereich von unten betritt, zum Senken der Heizwanne (81) zum Trennen des Bodens des Gefäßes von dem Heizfluid;
(c) wenn der Wert des Temperatursignales oberhalb des Sicherheitsbereiches ansteigt, zum Zuführen von Kühlflüssigkeit zu dem Kühlmantel;
(d) wenn die Werte der Signale von den Waagen (22, 32, 42), die das laufende Gewicht darstellen, von den gewünschten Werten abweichen, zum Ausgeben von Signalen, die der Abweichung entsprechen, an die Geschwindigkeitseinsteller (51, 52 und 53) zum Halten des Gewichtes der Behälter in der Nähe der gewünschten Werte zu einer gegebenen Zeit; und
(e) wenn der Flüssigkeitspegelsensor (91) ein Signal für eine obere Grenze erzeugt, zum Öffnen eines Ventilationsventiles (nicht gezeigt).

2. Vorrichtung nach Anspruch 1, in der einer der Behälter (3) für eine Säureflüssigkeit und ein anderer (4) für eine Basenflüssigkeit dient, und bei der ein pH-Detektor vorgesehen ist, der einen Sensor in den Reaktionsflüssigkeiten enthält und ein Signal entsprechend dem laufenden pH-Pegel in den Flüssigkeiten erzeugt, wobei die CPU (5) das pH-Signal empfängt und es bei der Steuerung seiner Ausgangssignale für die Geschwindigkeitseinsteller (52, 53) benutzt, die mit den Behältern (3, 4) verknüpft sind, damit der pH-Wert auf einem vorbestimmten Pegel gehalten wird.

**Revendications**

1. Appareil pour la réalisation et la régulation d'une réaction chimique comprenant:
un récipient de réaction (1) pour recevoir et mélanger une pluralité de liquides en vue d'une réaction;
une pluralité de réservoirs (2, 3 et 4) pour contenir une provision d'additifs liquides pour ledit récipient de réaction (1);
un nombre égal de pompes (P1, P2 et P3) pour le transport desdits additifs liquides à partir des réservoirs respectifs vers ledit récipient de réaction;
un nombre égal de moteurs (M1, M2 et M3) pour actionner lesdites pompes sous le contrôle de régleurs de vitesse respectifs (51, 52 et 53);
une pluralité de balances de pesage (22, 32 et 42) pour le contrôle du poids des additifs respectifs dans les réservoirs (2, 3 et 4);
un détecteur de température (TS) pour l'émission d'un signal qui correspond à la température des liquides de réaction dans ledit récipient de réaction;
des détecteurs de niveau de liquide (91, 92) dans ledit récipient de réaction pour l'émission de signaux qui correspondent au niveau du liquide dans ledit récipient de réaction;
une chemise de refroidissement (71) qui enveloppe la surface extérieure dudit récipient de réaction en vue d'un refroidissement forcé du récipient à partir de l'extérieur en recevant un liquide de refroidissement d'un refroidisseur (7);
une cuve chauffante (81) contenant un fluide de chauffage préchauffé à une température requise, ladite cuve pouvant être déplacée par un élévateur dans une position de chauffage par rapport au fond dudit récipient de réaction et en être retirée, ceci pour un chauffage forcé du récipient de réaction lorsque le fond du récipient est immergé dans le fluide de chauffage et pour permettre le rayonnement de la chaleur à partir du récipient de réaction lorsque le fond du récipient est retiré du fluide de chauffage; et
une unité de traitement centrale (CPU) (5) branchée de façon à recevoir des signaux desdits détecteurs de température, desdits détecteurs de niveau de liquide et desdites balances de pesage pour la réalisation et la régulation de la réaction,
caractérisé en ce que ladite CPU est conçue pour fonctionner;
(a) lorsque la valeur du signal de la température est inférieure à un domaine de sécurité, afin de soulever la cuve chauffante (81) pour plonger le fond du récipient de réaction dans le fluide de chauffage de façon à ce qu'une zone de contact requise soit chauffée;
(b) lorsque la valeur du signal de la température entre dans le domaine de sécurité par le bas, afin de baisser la cuve chauffante (81) pour séparer le fond du récipient de réaction du fluide de chauffage;
(c) lorsque la valeur du signal de la température monte au-dessus du domaine de sécurité, afin de fournir du liquide de refroidissement à ladite chemise de refroidissement;
(d) lorsque les valeurs des signaux desdites balances de pesage (22, 32 et 42), qui indiquent le poids du moment, dévient des valeurs requises, afin d'émettre des signaux correspondant à cette déviation vers les régleurs de vitesse (51, 52 et 53) de sorte à maintenir le poids des réservoirs endéans un voisinage donné par rapport aux valeurs

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requises à un moment donné; et
(e) lorsque le détecteur du niveau de liquide (91) émet un signal relatif à la limite supérieure, afin d'ouvrir une soupape de ventilation (non montrée).

2. Appareil comme revendiqué dans la revendication 1, dans lequel un desdits réservoirs (3) est pour un liquide acide et un autre (4) pour un liquide basique et dans lequel on a aménagé une détection de pH comportant une sonde qui est logée au sein des liquides de réaction et qui produit un signal électrique correspondant au niveau de pH momentané des liquides, ladite CPU recevant ledit signal de pH et utilisant celui-ci dans le contrôle de ses sorties de données vers les régleurs de vitesse (52, 53) associés aux réservoirs (3, 4), de sorte à maintenir le niveau du pH à une valeur désirée.