DOWNHOLE DUMP VALVE

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention is broadly concerned with a reliable dump valve assembly to be used as a part of a downhole pipe string employed in oil wells or the like, in order to permit selective draining of pumping fluid from the pipe string prior to elevation thereof to the surface, thereby eliminating or minimizing environmental contamination caused by fluid drainage from the pipe string. More particularly, the invention is concerned with such a dump valve assembly which preferably makes use of a metallic, frangible, concavo-convex rupture disc which is configured for reliably bursting at a predetermined internal fluid pressure.

Description of the Prior Art

Conventional oil or gas wells include an annular, cementitious elongated casing extending from grade down to the recoverable oil supply. An elongated, tubular, multiple-section pipe string is positioned within the casing and in turn houses and/or is attached to an artificial lift system.

It is necessary from time to time to extract the artificial lift system or their components for servicing thereof. This involves elevating the pipe string and/or sucker rod assembly, and detaching these parts section by section. However, owing to the fact that the pipe string is filled with pumping fluid, it sometimes occurs that this fluid is simply drained at grade during the dismantling process; this is objectionable because of the environmental pollution it causes.

It has been known in the past to provide dump valve units associated with downhole pipe strings which can be remotely actuated so as to drain the pipe string prior to and during the extraction process. For example, U.S. Patent No. 4,286,662 describes a tubing drain fitted into the sidewall of a short pipe section coupler which has a blowout piston retained in place by a shear pin. A similar device has been commercialized under the designation "Series 500 Tubing Drain" by Quinn's Oilfield Supply Ltd. of Red Deer, Alberta.

SUMMARY OF THE INVENTION

The present invention provides an improved dump valve assembly adapted for interconnection between a pair of elongated downhole pipe sections forming a part of a downhole pipe string, with the dump valve assembly permitting selective drainage of fluid from the string. The assembly of the invention is relatively inexpensive and affords reliable drainage of a pipe string through the simple expedient of pressurizing the column of pumping fluid within the string to a predetermined pressure (e.g., 2000 psi).

Broadly speaking the dump valve assembly of the invention is operable for interconnecting a pair of string pipe sections in an end-to-end relationship and includes an elongated, tubular pipe section connection body presenting opposed ends in a sidewall; the ends have structure for interconnecting the pair of pipe sections, whereas the sidewall has opposed inner and outer surfaces and is configured to present an opening therethrough. A fitting is located within the sidewall opening and includes a metallic, frangible, shape-retaining rupture disc oriented for normally preventing fluid flow through the sidewall opening. The rupture disc has at least one line of weakness formed therein for reliable rupture thereof upon pressurization of the fluid within the pipe string in order to permit drainage thereof. Preferably, the rupture disc is of concavo-convex configuration and is oriented with the concave face thereof proximal to the inner face of the connection body sidewall; the lines of weakness may be formed by grinding or other ablation processes, but preferably are formed by scoring.

The fitting is normally in the form of an annular metallic housing presenting inboard and outboard surfaces and is adapted for receipt within the sidewall opening, with the rupture disc being fixedly secured to the housing (preferably by permanent welding). The sidewall opening and outboard surface of the housing are complementally threaded for threaded mounting of the housing within the sidewall. Accordingly, it is a simple matter to replace the fitting after each use of the dump valve assembly. The housing also normally includes structure for retaining the disc upon rupture thereof, although in preferred forms the disc is provided with lines of weakness arranged so as to eliminate or minimize the possibility of disc fragmentation upon rupture thereof.

Preferred rupture discs in accordance with the invention includes a pair of intersecting, transverse score lines on the convex face thereof. The disc should normally have a thickness of from about .003-.090 inches, and more preferably from about .010-.040 inches. The score lines should have a depth of from about .001-.060 inches. The disc should moreover be formed from a metal having appropriate

characteristics to withstand several downhole conditions, such as stainless steel, nickel or Inconel.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic, fragmentary view in partial vertical section illustrating typical downhole well components including an outermost casing, an elongated, tubular, multiple section pipe string, a sucker rod assembly within the pipe string, and the dump valve assembly of the present invention interconnected between lower pipe sections of the string;

Fig. 2 is an enlarged, fragmentary view of the portion of the downhole pipe string occupied by the dump valve assembly of the invention;

Fig. 3 is a vertical section view taken along line 3-3 of Fig. 2 and illustrating in detail the configuration of the dump valve assembly, the latter shown with the rupture disc thereof in its fluid flow-blocking relationship; and

Fig. 4 is a vertical sectional view similar to that of Fig. 3but depicting the rupture disc in its ruptured condition.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Turning now to the drawings, and particularly Fig. 1, an oil well 10 is illustrated. The latter includes, within the well bore, a cementitious annular casing 12 leading from grade 14 to a lower recoverable supply 16 of petroleum product. An elongated, multiple-section, end-to-end interconnected tubular pipe string 18 is positioned within the casing 12 and includes individual, threadably interconnected pipe sections 20.

A dump valve assembly 22 is interconnected between a pair of lower pipe sections 20a and 20b as shown. The assembly 22 includes an elongated, tubular pipe section 24 supporting a rupture disc fitting 26.

Referring to Figs. 3 and 4, it will be observed that the lower end of pipe section 20a has external pipe threads 28, whereas the upper end of complemental section 20b has internal threads 30. As will be readily understood, these pipe sections 20a, 20b could be interconnected by threading the lower end of section 20a into the upper end of section 20b. However, the assembly 22 is interconnected between these pipe sections and for this purpose, the upper end 32 of the sidewall 24 has internal pipe threading 34 complemental with the threading 28; similarly, the lower end 36 of the sidewall 24 has external threading 38 complemental with threading 30 of pipe section

20b. It will thus readily be seen that the sidewall 22 forms a tubular interconnection between the pipe sections.

The sidewall 22 also has a threaded, lateral opening 40 therethrough intermediate ends 32 and 36. This opening 40 is designed to accept the metallic fitting 26. The latter has a circular housing body 42 having external threading 44 mating with the threading of opening 40. The outer end of housing body 42 is configured to present a hexagonal opening 46 presenting flats for insertion of a rotatable shank tool. The inboard annular face of the housing 42 is configured to receive and support the annular margin 48 of a metallic rupture disc 50. As shown, the disc 50 is of generally concavo-convex configuration and is oriented with the concave face thereof adjacent the inner surface of sidewall 24. Normally, the margin 48 is permanently welded to the inboard annular face of the housing 42. Referring to Fig. 2, it will be seen that the concave face of the disc 50 is provided with a pair of intersecting score lines 52, 54 which extend substantially the full extent of the bulged face thereof.

In one preferred embodiment, the housing 42 is formed of #304 stainless steel, whereas the rupture disc is fabricated from Inconel, a known nickel alloy, and has a thickness of about .010 inches. The score lines have a depth of about .005 inches.

It will be appreciated that during normal use of the assembly 22, the disc 50 remains in its intact, non-ruptured condition, and in no way detracts from the usual operation of the pipe string 20 or other well components. However, when it becomes necessary to withdraw the pipe string from the well casing, it is only necessary to pressurize the column of fluid within the pipe string 20 to a predetermined extent sufficient to rupture the disc 50. In the indicated embodiment, pressurization to a level of about 2000 psi is sufficient to rupture the disc. This orientation is illustrated in Fig. 4, where it will be seen that the disc ruptures along the score lines 52, 54 so as to create four circumferentially spaced "petals". It will be observed in this respect that the housing 42 is configured so as to retain these "petals" in the event that one or more breaks free from the disc.

It will thus be seen that the present invention provides a greatly improved and reliable downhole dump valve assembly which gives improved operational characteristics as compared with prior dump valves.

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We claim:

1. A dump valve assembly adapted for interconnection between a pair of elongated downhole pipe sections forming a part of a downhole pipe string, said assembly operable for interconnecting said sections in an end-to-end relationship and permitting selective drainage of fluid from the pipe string, said dump valve assembly comprising:

an elongated, tubular pipe section connection body presenting a pair of opposed ends and a sidewall, said ends having structure for interconnecting said pair of pipe sections, said sidewall having opposed inner and outer surfaces and configured to present an opening therethrough; and

a fitting located within said sidewall opening and including a metallic, frangible, shape-retaining rupture disc oriented for normally preventing fluid flow through said sidewall opening,

said rupture disc having at least one line of weakness formed therein for reliable rupture of the disc upon pressurization of said fluid within the pipe string to a predetermined pressure in order to permit drainage of said fluid from the pipe string.

2. The assembly of claim 1, said fitting including an annular metallic housing presenting opposed inboard and outboard surfaces and adapted for receipt within said sidewall opening, said disc being fixedly secured to said housing.

3. The assembly of claim 2, said sidewall opening and the outboard surface of said housing being complementally threaded for threaded mounting of the housing within the sidewall opening.

4. The assembly of claim 2, said rupture disc being permanently welded to said housing.

5. The assembly of claim 2, said housing including structure for retaining said disc upon rupture thereof.

6. The assembly of claim 2, said housing presenting a generally hexagonal tool-receiving opening remote from said disc for receipt of an insertion/removal tool.

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7. The assembly of claim 1, including a pair of intersecting, transverse lines of weakness formed on the convex face of said rupture disc.

8. The assembly of claim 7, said lines of weakness being score lines.

9. The assembly of claim 1, said disc having a thickness of from about .003-.090 inches.

10. The assembly of claim 1, said rupture disc being formed of a metal selected from the group consisting of nickel, stainless steel and Inconel.

11. The assembly of claim 1, said rupture disc being of concavo-convex configuration.

12. The assembly of claim 11, said disc being oriented with the concave face thereof proximal to the inner face of said sidewall.

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