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Design and Simulation of Joint Valve for Petroleum Equipment Units

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Abstract: Connecting and separating every modularized petroleum unit without leakage is very difficult, one novel petroleum equipment joint valve is designed in this study which can switch on or shut off pipeline automatically when petroleum equipment units are connected or separated, this joint valve can assure petroleum is not leaked from pipeline when petroleum equipment units are connected or separated. Its 3D model is built in Pro/E and the kinetics analysis and simulation of the key point of the joint valve is done in ADAMS, the results of simulation shows connecting and separating the joint is convenient and rapid. It provides convenience for modularizing petroleum equipment unit.

Key words: Petroleum equipment, joint valve, design, simulation

INTRODUCTION

The mode of exerting modularized petroleum equipment is various. Its function modules have strong extension ability. It can not only strengthen safeguard competence of petroleum equipment, but also it is convenient for design, manufacture, usage and maintenance of petroleum equipment. At the same time it can also reduce production and using cost (Mu *et al*., 2009). But it is very difficult for petroleum equipment units to be connected or separated without leakage (Li and Feng, 2007). At the present time, ordinary joint valve for petroleum equipment has screw thread joint, flange joint, slot joint and airplane refueling joint shutting off automatically when they separated and so on (Liu, 2002). Screw thread joint connects pipeline with screw thread, rough silk twine is often tangled in pipeline head with outer screw thread in order to enhance gastight character of the pipelines, flange joint puts mat slice between two flanges, using bolt to band two flanges together, its virtue is high link strength and convenient for assembling, but flange joint cannot adjust angle deviation, CRJ joint with sharp tempo has the character of taking down rapidly, but its gastight character is poor. These joints cannot be shut off automatically when pipelines separate, so a little petroleum leaks from joint when pipeline is separated. Airplane refueling joint can be shut off automatically when they are separated, but a little petroleum leaks when it is very important to design one novel petroleum equipment joint which can switch on or shut off pipeline automatically and can assure petroleum is not leaked from pipeline when petroleum equipment units are connected or separated (Li and Tian, 2011).

STRUCTURE DESIGN

Joint valve for assembled petroleum equipment is composed of negative end and positive end (Fig. 1).

Negative end of joint: Negative end of joint valve is shown in Fig. 2a when it is connected. Negative end of

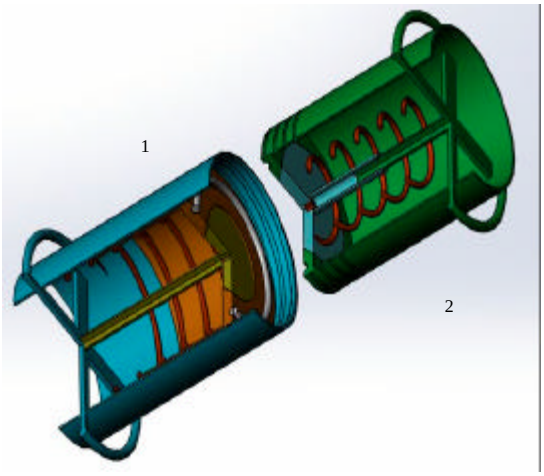

Fig. 1: Shutting off status of joint valve (1) Negative end (2) Positive end

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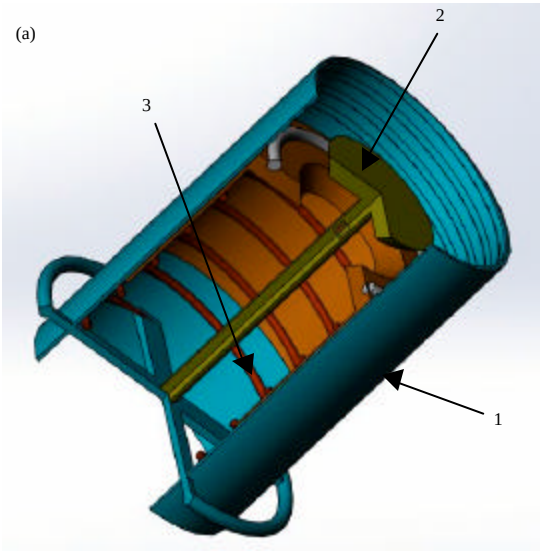

Fig. 2(a-b): Negative end of joint valve (1) Valve body (2) "O" shape seal ring (3) Spring

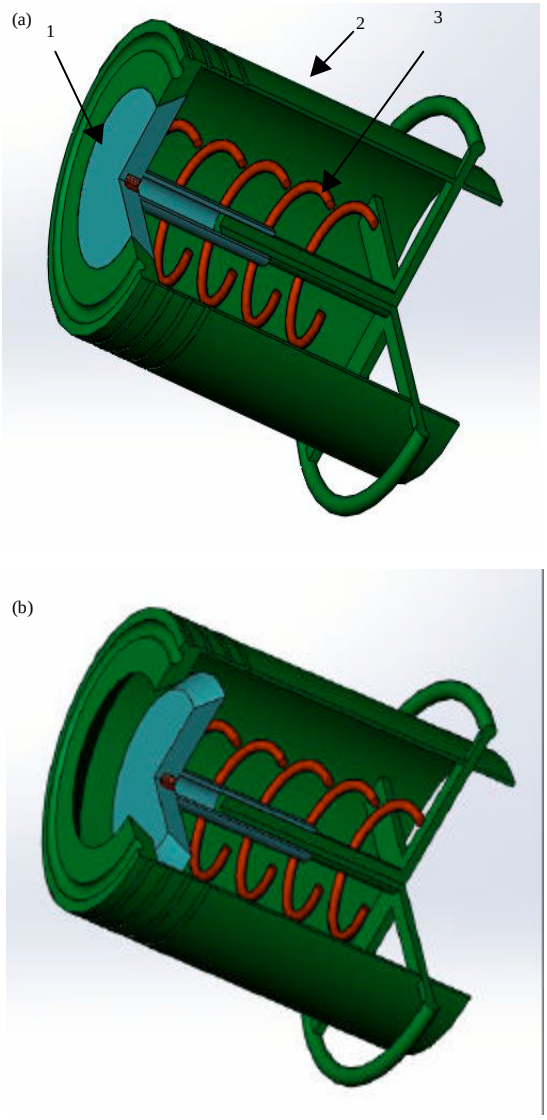

Fig. 3(a-b): Positive end of joint valve (1) Valve lamella (2)Valve body and (3) Spring

joint valve is shown in Fig. 2b when it is separated. It is mostly composed of valve body, movable hollow cylinder, spring, valve lamella and "O" shape seal ring etc. Valve body is mostly composed of cylinder, valve seat and disc etc.

Positive end of joint valve: Positive end of joint valve is shown in Fig. 3a when it is separated. Negative end of joint valve is shown in Fig. 3b when it is connected. It is mostly composed of valve body, spring, valve lamella, "O" shape seal ring etc. Valve body is mostly composed of cylinder, valve seat and disc etc.

WORKING PRINCIPLE

Every part of the joint valve acts coordinately, it has the characters as follows:

- Both ends of the joint valve can shut off automatically when they separate one another and petroleum is not leaked from joint valve
- Force of operating the joint is small, outline form is beautiful and small, the quality of the joint is light
- Credibility of the joint is great, connecting and separating the joint is convenient

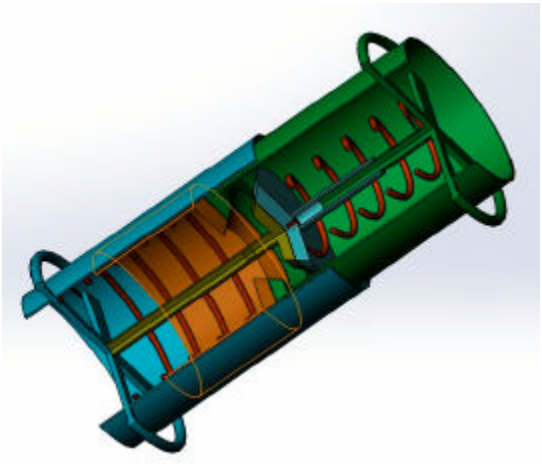

Fig. 4: Switching on status of joint valve

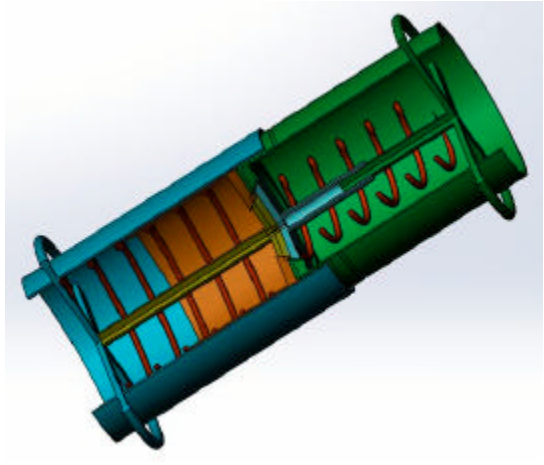

Fig. 5: Critical status of switching on or shutting off joint valve

Connection of the joint: Valve body cylinder of positive end overcomes stress force of negative end spring and push cylinder of negative end, making cylinder of negative end separated from valve lamella of negative end, thus negative end of the joint valve is switched on, at the same time valve lamella of negative end overcome stress force of positive end spring and push valve lamella of positive end, making valve body of positive end separated from valve lamella of positive end, thus positive end of the joint valve is switched on, so the joint valve switch on automatically and petroleum can flow in the pipeline of petroleum equipment unit after positive end and negative end are connected (Fig. 4). Negative end of the joint valve is connected with its positive end by screw thread. Inner cylinder bottom of negative end and cylinder bottom of positive end is touched (Fig. 5) and sealed by "O" type seal ring (Fig. 1) before valve lamella of negative end and valve lamella of positive end are opened.

Separation of the joint: Before positive end of the joint valve and its negative end are separated, they shut off gradually (Fig. 4), when they shut off completely, valve lamella of negative end and valve lamella of negative end keep touched (Fig. 5), Inner cylinder bottom of negative end and cylinder bottom of positive end keep touched, so there is not space between negative end and positive end and petroleum cannot leak from the joint valve when positive end of the joint valve and its negative end are separated (Fig. 1).

SIMULATION

The 3D model of joint valve is built in Pro/E, the assembling model is saved as paraboloid (.x_t) type and

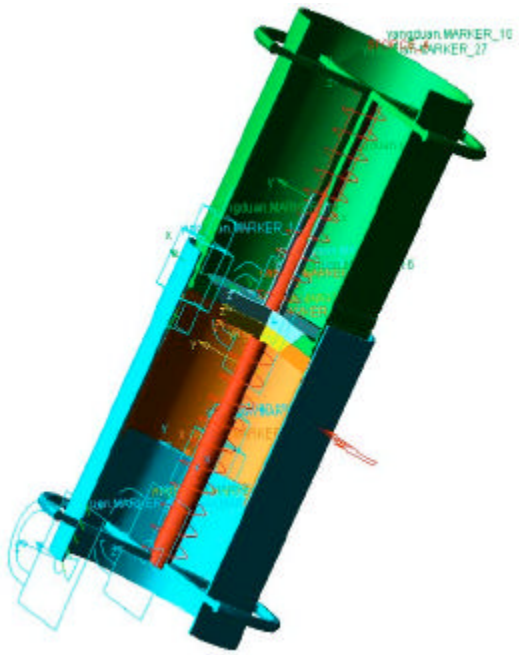

Fig. 6: Simulation model of joint valve

is imported in ADMAMS (Fig. 6). The material is chosen as carbon steel (Li, 2006). A glide pair is built between the valve bar and the cylinder, a fixed pair is built between valve body of negative end and valve lamella, spring dampers are built between the valve lamella and bottom plate o f the valve body, the stiffness of the spring is 0.24 newton/mm, the damper coefficient is 0.64 newton-sec/mm. Associate simulation parameters are set and the simulation on the negative end inner cylinder MARKER_30 point is done (Fig. 7), from Fig. 7 we can see

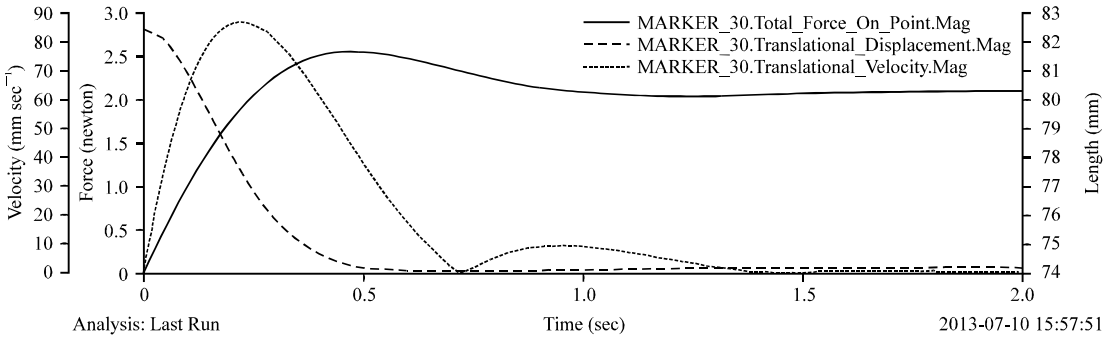

Fig.7: Simulation curve of negative end cylinder MARKER30 while connecting joint valve

connecting the joint valve need 2.5 newton stress force, translational displacement of negative end inner cylinder is 8.1 mm when negative end and positive end connect or separate. Translational velocity shutting off or switching on joint valve is increasing to 85mm/sec gradually at first and then reducing to zero gradually.

CONCLUSION

This innovated petroleum equipment joint can switch on or shut off pipeline automatically without leakage when petroleum equipment units are connected or separated.

Force of operating the joint is small, outline form is beautiful and small and quality of the joint is light. Credibility of the joint is great, connecting and separating the joint is convenient and rapid. It provides convenience for modularizing petroleum equipment unit.

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