

Workplace Health and Safety Bulletin



Worker Seriously Injured Servicing a Plunger Lift System

Incident description

A service technician was seriously injured while servicing a plunger lift system. This recent incident occurred when an unsuspecting ice plug in the wellhead lubricator released and struck the worker in the head resulting in a fractured skull and permanent eye loss.

The Workplace Health and Safety investigation revealed that many other near-miss incidents have occurred involving plunger lift systems. These include lubricator failures and temporary loss of well control due to plungers rupturing the lubricators on the return trip to surface. However, since no injuries were associated with these occurrences, these incidents have not been recorded.

The gas and oil market trends indicate that use of this technology is increasing. With more workers being exposed to this equipment, it is critical that workers tasked with operating and maintaining these systems are trained and aware of the system operating limits and potential hazards associated with the equipment and operation.



Equipment

The plunger lift consists of:

- a surface lubricator;
- a free moving piston (plunger) that uses the well's energy to move fluid up the production tubing or casing;
- a bottom hole landing assembly for the plunger to land on at the bottom of the well; and
- an electronic control system to open and close a pneumatic valve on surface at preset times or pressures which allows the plunger to drop to the bottom of the production string and open the well to bring the plunger and produced liquid to surface.

Ice, hydrates, wax, paraffin, sand and other produced elements are potential hazards that may affect the performance of plunger lift equipment, especially the surface equipment.

When installed and serviced properly the plunger lift system is a safe and effective method of unloading gas and oil wells. However, proper operator training and correct equipment design, maintenance and operation are critical in minimizing any potential hazard and risk to the operating personnel.

Contributing factors

The following are the contributing factors to this incident:

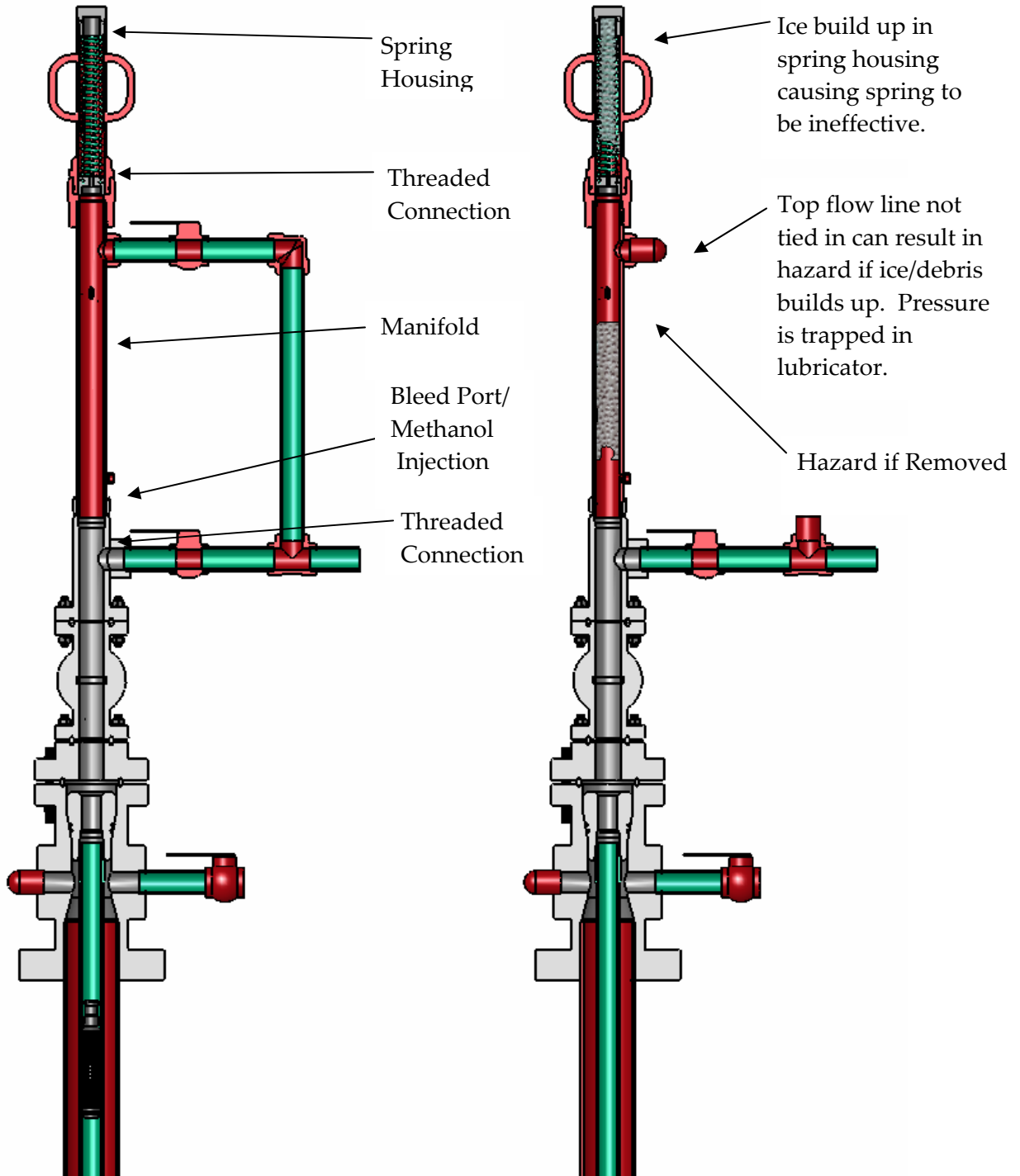
- Ice build up in the lubricator assembly.
- The ice build up in the lubricator was caused by produced water freezing in the assembly and no method of thawing the wellhead was available at this particular work site.
- Poor procedures in identifying potential hazards.
- Lack of operator training in safe work practices for the use of this equipment.
- No record of previous occurrences is available in the industry to track trends of incidents.
- No standard installation and servicing requirements are available to the industry.

Discussion

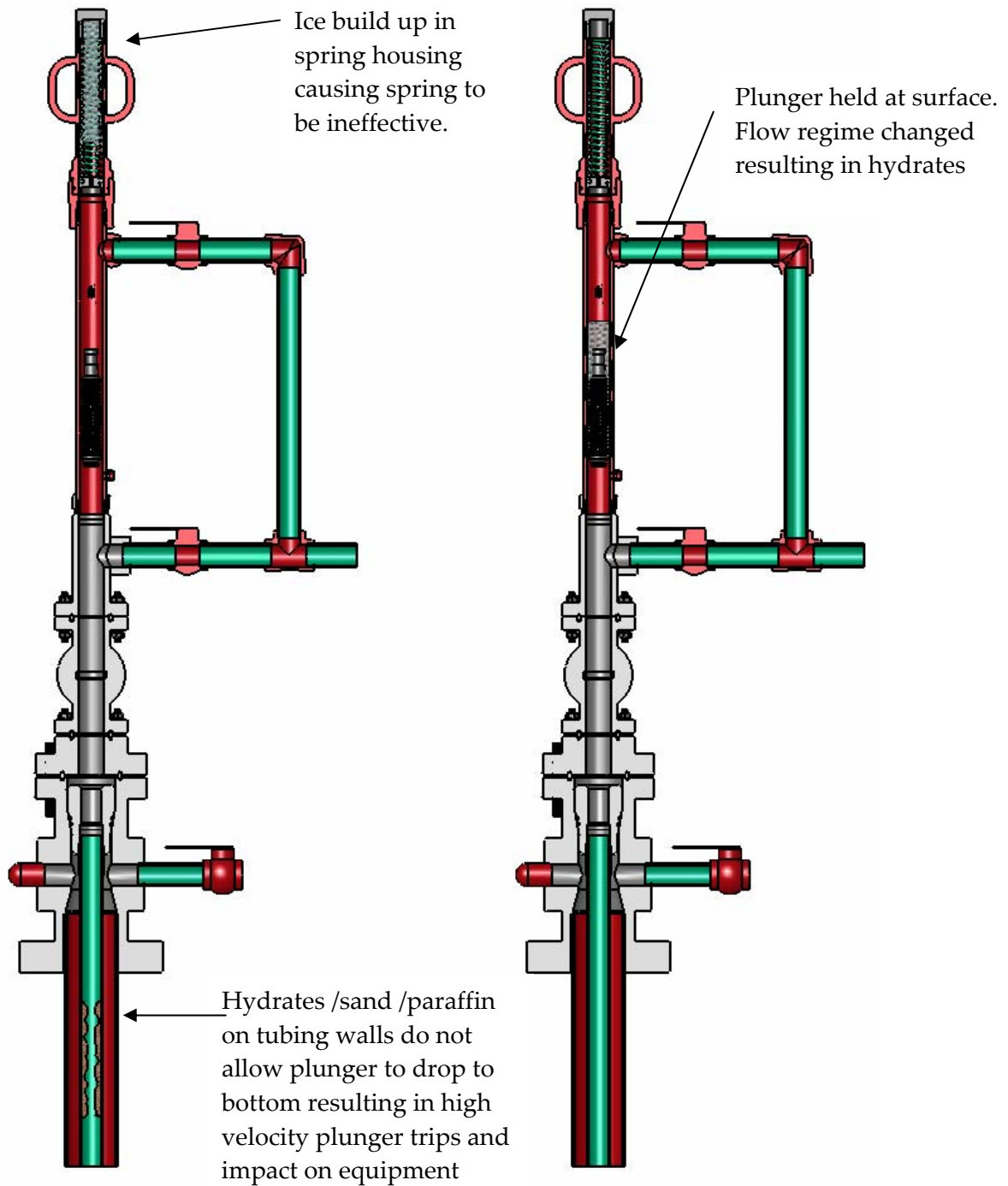
Plunger lift systems are designed to operate on pre-determined time or pressure cycles. While the system will operate safely within these parameters, there are a number of factors that can cause the system to fail and have potentially serious consequences if the understanding of the design criteria and operating procedures are not known. Sources of potential injury and equipment failure are:

- Removing lubricator components with pressure contained above or below ice plugs, sand bridges etc.
- Ice build up in the spring housing causing impact forces of the plunger to be transferred to the lubricator housing and well head threads resulting in catastrophic equipment failure
- Paraffin, wax, sand and hydrates build up in the tubing string which will not allow the plunger to drop to the bottom of the well resulting in shorter, faster plunger arrivals at surface and impacting the lubricator assembly with greater force than normal
- Poorly designed springs or stops that are supposed to absorb the impact of the plunger at surface
- Plungers traveling “Dry” with little or no fluid – fluid on top of the plunger also aids in dampening the impact of the plunger at surface
- Changes in line pressures resulting in faster higher velocity plunger arrivals
- Changes in the plunger configuration - as the well declines different plungers of various weights and lengths may be used to aid in production optimization and the travel velocity will also change
- No methanol injection or heat trace to keep ice and hydrates from forming in the lubricator assembly
- Restricted flow path if the plunger is being held at surface causing a pressure drop and creating the environment for the formation of hydrates
- Unexpected changes in flow regimes caused by cycling a plunger – sand production due to higher drawdown effect on the reservoir
- High pressure and volumes of gas and fluid affecting surface equipment due to the cyclic nature of plunger operations

a) Typical Plunger Lift Installation b) Hazards from Not Tying in the top flow line



c) Hazards Associated with Impact Velocity d) Hydrate Potential with Plunger Lift



Recommendations

- Equipment should be of a design and function to withstand operating conditions with built-in safety factors.
 - Equipment should be impact rated as well as pressure rated-API 6A specifications for wellheads cover tensile and pressure but the potential for impact forces caused by malfunctioning plungers is not covered or discussed.
 - Electronic control boxes should be set to record high velocity plunger times and to shut down after one or more high velocity arrivals.
 - Operators need to be trained to recognize why plungers are traveling at higher speeds and impacting with greater force and the potential consequences of repeated impacts on surface equipment.
 - Installation and servicing procedures including risk and hazard control should be standard with all plunger installs.
 - Methods of controlling hydrate, ice build up should be considered when installing plungers on gas wells especially during winter months.
 - Industry awareness and training that covers not only the functionality but the hazard assessment and safe working guidelines should be generated by each manufacturer for their specific equipment and operating guidelines.
 - Well operators should not listen for plunger activity by putting their ears onto the lubricator. This is a dangerous, but common practice.
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