ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 4, Issue 9, March 2015

To Study the Phenomena of Thermal Binding and Pressure Locking on Wedge Gate Valve and the Methods to Reduce their Effects

(a)Dr.Gurudutt sahni, (b)Jaspreet Singh, (c)Tajinder Singh
(a) (HOD & DGM (Design, Drawing & Development) LEADER VALVES LTD JALANDHAR, PUNJAB, INDIA) &C Eng (INSTITUTION OF ENGINEERS INDIA) & QMS LEAD AUDITOR
(b) (SCHOLAR OF MECHANICAL ENGG.(1282883) AT DAV INSTITUTE OF ENGG. AND TECHNOLOGY JALANDHAR)
(c) (SCHOLAR OF MECHANICAL ENGG.(1282887) AT DAV INSTITUTE OF ENGG. AND TECHNOLOGY JALANDHAR)

ABSTRACT: ***The ability of the gate valve to open and close can be difficult to safe operation of the any power plant. This paper represents the unwedging thrust of the gate valve exposed to Temperature and Pressure changes between the opening and closing stroke of the gate valve. This unwediging thrust of the valve resulting in changes in bonnet, upstream OR downstream pressure and temperature difference that will cause of Pressure locking and Thermal binding of the wedge of the gate valve Phenomena.***

KEY WORDS: **Thermal binding, Pressure locking.**

I. OBJECTIVES

- To study about the basic parts of the valves.
- To know about the effect of Pressure Locking in gate valve.
- To know about the effect of temperature on the valve seat.
- To find the solution to reduce the thermal binding and pressure locking.

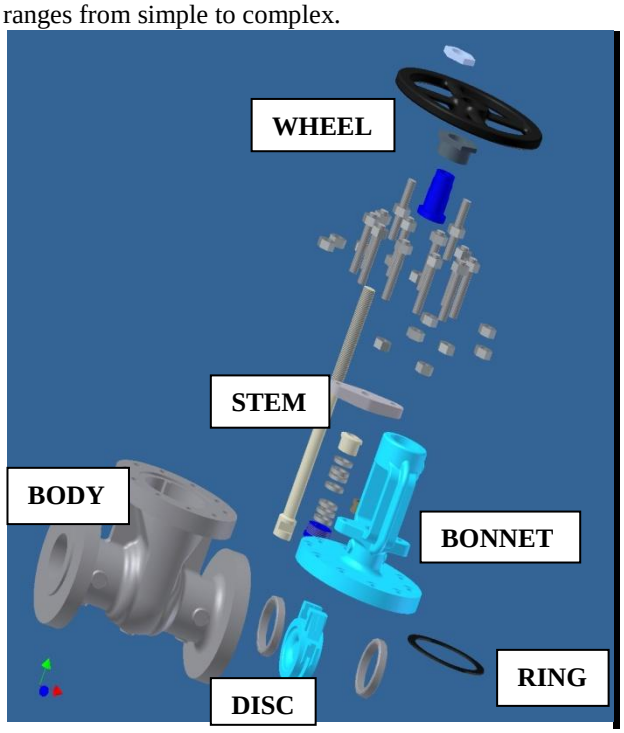
II. INTRODUCTION

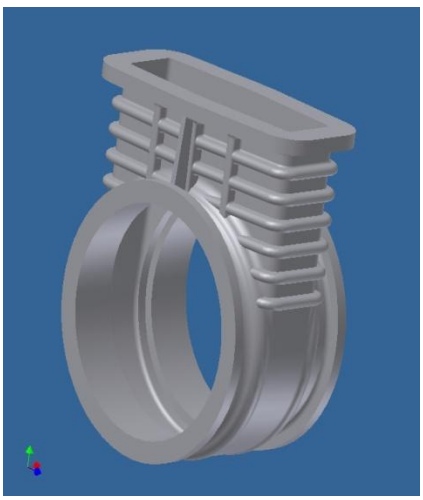
A valve is the device which is used to control the flow and pressure of the fluid in the system. The valve basically operates the following functions:

- To start and stop the flow of the fluid.
- To control the pressure of the fluid in the pipe line OR system.
- To control the pressure of the fluid in the system.

There are so many valves are used in the system. These valves are used according to their purposes. Basically all the valves have some basic parts: body, bonnet, disc, seat, and stem, handle.

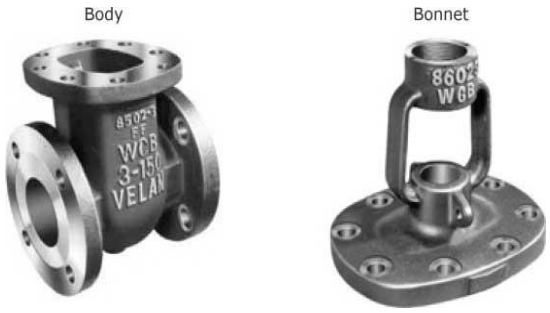
BODY: Body is the main part of the valves. It is the exterior part of the valve together with the bonnet. The body is the part, where the d pass through it. When the valve is open then the fluid will come from the part of the body to another. Body of the valve has to withstand with many forces inside the valve. It is the first pressure boundary of the valve that resists the fluid pressure load. It also experiences many forces due to the end connections of valve. The basic form of the valve body ranges from simple to complex.



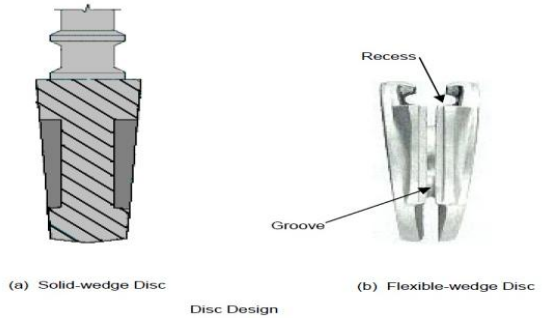


ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 4, Issue 9, March 2015

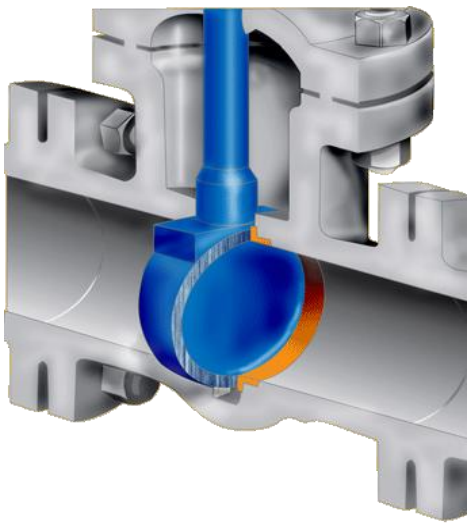
VALVE BONNET: The valve bonnet is basically the cover of opening in the valve body. Some bonnet function simply as a valve cover while the other support the valves and accessories such as the stem, disc and actuator. It is the second pressure boundary of the valve. It is the cast or forged of the same material as the body and is connected to the body by means of threads, welding and bolts. Basically bonnets are the source of the leakages in the valves.



DISK: The disk is also a valve member. Its function is to obstructing and permitting the flow of fluid in the body of the valve. When the disk is lifted, fluid could go through the body. If it is down and closed, fluid would be obstructed from entering the other side of the body valve.



SEAT: Paired with the disk, it is responsible for obstruction of matter. The disk faces difficulties to stay in place and stay in the way of the fluid without its seat. Basically the seats are made of the same material as the valve itself. Soft seats are made of softer and hard seats of harder material.



STEM: The stem is main connection between the disk and handle and it acts as the motion transmitter between them. Rising stems would be it easier for people to close and open the valve, and non-rising stem are more complete arrangement.

HANDLE: Handle and wheels are used to permit the flow of matter. The main purpose of valve is to control the flow of fluid. With the adjusting of handle, we can control the flow of the fluid from one part of the body to another.

Valve Trim: The internal element of a valve is known as a valve's trim. It includes a disk, seat, stem, and sleeves needed to guide the stem. The valve performance can be determined by the disk and seat interface and the relation of the disk position to the seat. Because of the trim, basic motions and flow control are possible.

Valve Actuator: The actuator operates the stem and disk assembly. An actuator may be a manually operated or hydraulic ram. In some designs, the actuator is supported by the bonnet. Actuators are always at the outside of the pressure boundary.

Valve Packing: Packing is used to prevent leakage from the space between the stem and the bonnet. Packing is commonly a fibrous material or another compound that forms a seal between the internal parts of a valve and the outside where the stem extends through the body. Valve packing must be properly compressed; if a valve's packing is too loose then the valve will leak. If the

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 4, Issue 9, March 2015

packing is too tight, it will impair the movement and possibly damage the stem.

III. THERMAL BINDING AND PRESSURE LOCKING

The thermal binding and pressure locking are the well-known concept in case of valve. Pressure locking all thermal binding occurs when the valve is subject to specific temperature and pressure during the operation.

THERMAL BINDING: Thermal binding can occur when thermal expansion OR contraction effects cause the disc to be squeezed between the valve body seats. If the loads associated with thermal binding are very high, the actuator might be difficult to open the valve.

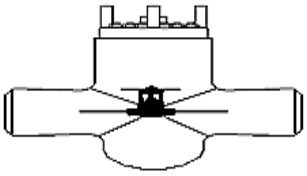
Thermal binding is caused by dimensional interference between the wedge and seat due to temperature differences in the wedge of the gate valve.

Thermal binding is generally associated with wedge gate valve that is close while the system is hot and then allowed to cool before attempting to open the valve.

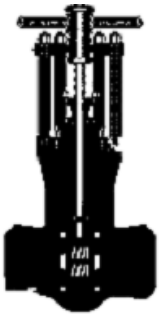
Thermal binding occurs mostly at higher temperature conditions.

THERMALBINDING SOLUTION

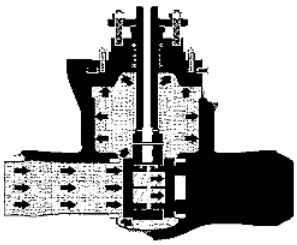
1. Install a bypass pipe and valve on the upstream and downstream of the body. This will allow warm up of both sides of the wedge.
2. After closing the valve, back off the stem a ¼ of a turn to allow for stem expansion.



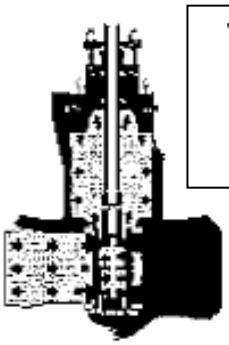
3. The Parallel Slide Valve is preferred over the Flex Wedge in high temperature applications as there is no possibility for Thermal Locking and because seat integrity increases with increasing pressure.



4. The Parallel Slide Valve is a dynamically energized valve. It uses the process pressure to press the disc against the seat.
5. As the process pressure rises it will overcome the upstream disc spring force and push the disc away from the seat thereby permitting process pressure into the body cavity.



6. The stem thrust required for seating and unseating the valve is calculated from the Seating Force + Stem Load + Stem Packing Friction.
7. Seating Force is calculated from the Valve Seat Area x Max Differential x Valve Factor.



THE HIGHER THE PRESSURE THE HIGHER THE SEALING

PRESSURE LOCKING: Pressure Locking occurs when the valve is closed and pressure increases in its cavity or when the line pressure decreases without decreases in the body bonnet area.

1. Temperature in the valve bonnet might increase in response to heat up during plant operation, ambient air temperature rise due to leaking components or pipe breaks.
2. The bonnet pressure could decrease by leakage past the seating surfaces or stem packing. If this does not occur, the depressurization time may be longer than the needed time to operate the valve.
3. Pressure Locking is due to condensate being trapped in the bottom pocket (belly) of the valve

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 4, Issue 9, March 2015

body. This may be the result residual condensate being present in the valve from the cooling process during shutdown or it may be condensate that is driven into the valve during

THE PRESSURE IS IMMEDIATELY SEEN BY THE DOWNSTREAM DISC AND FORCES IT AGAINST THE DOWNSTREAM BODY

OVER PRESSURIZATION IN BOTH PRESSURE SEAL AND BONNET VALVE DESIGNS

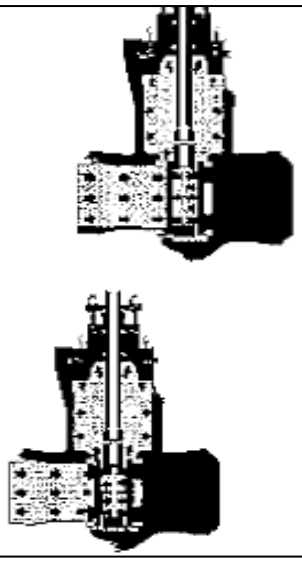
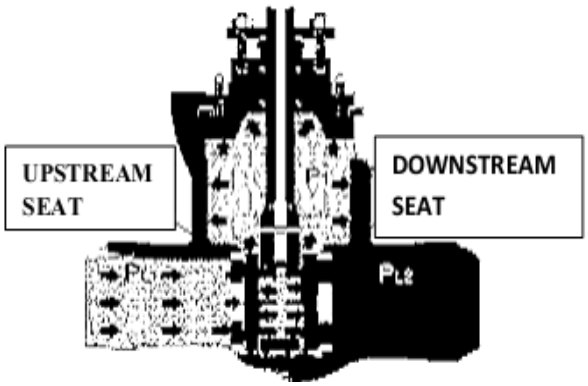


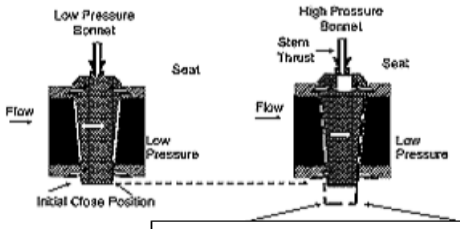
FIG 1 NORMAL PARALLEL SLIDE GATE VALVE OPERATION NOTE: SEALED ON DOWNSTREAM AS DESIGNED

4. The trapped fluid expands (P1), due to increase in temperature.
5. Typically, for each 1° F rise of temperature, a pressure increase of 150 psi occurs.
6. Not restricted to valve size.
7. Actuator sizing is normally based on stated torques of a normal operating Parallel Slide Valve sealing on the downstream body seat. During over pressurization the dynamic seating force is doubled because both discs are loaded from the internal pressure. End result is the actuator cannot operate the valve.



P1: PRESSURE OF TRAPPED FLUID BETWEEN SEATS PL1/PL2:LINE

8. **WEDGE GATE:** A gate valve, also known as a sluice valve, is a valve that opens by lifting a round or rectangular gate/wedge out of the path of the fluid.



THE HIGHER BONNET PRESSURE CAUSES THE BODY TO EXPAND THUS MOVING THE SEATS APART.THE STEM PUSHES THE DISC FURTHER DOWN

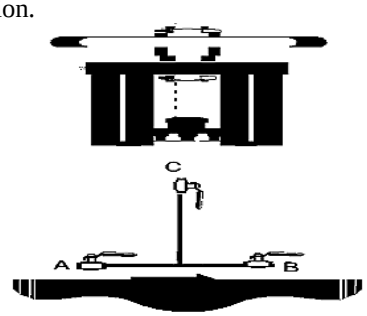
FIG 2 TRAPPED CONDENSATE IN VALVE NOTE: PRESSURE OF TRAPPED FLUID BETWEEN SEATS

PRESSURE LOCKING SOLUTION

1. Cycling the valve during start-up. The trapped condensate in the body cavity will be either flashed or siphoned away.
2. Installing a pressure release system of the body cavity. This can be accomplished by an equalizing pipe from the bonnet to the high pressure side of the valve (the valve will only seal in one direction when the valve is closed).
3. Installing an automatic relief valve or a manual drain valve to exhaust to the atmosphere (safety is suggested for both applications).
4. Drilling an internal hole in the wedge face to the high pressure side of the valve.

THREE LEGGED BYPASS SOLUTIONS

1. With the **A & B** valves open the valve seats are fully bypassed, and typical warm up or pressure equalization process can occur. The **C** valve can be open, or left closed for the typical bypass/warm up operation.
2. If all three valves are left continuously open, the system will constantly be equalized. However the valve is not capable of shutoff in this condition.



ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 4, Issue 9, March 2015

3. If all three valves are closed the valve becomes bidirectional as opposed to unidirectional, but no bonnet venting will take place.
4. With the **C** valve left open, when bonnet over pressurization occurs then either the single **A** or **B** valve, or both, can be opened to relieve pressure in the bonnet. It is recommended that only the **A** or **B** valve aligned with the HIGH PRESSURE SIDE be opened in this circumstance.

REFERENCES

[1] Valve handbook by GH Pearson

[2] Valve handbook by Philipl.skousen.

[3] Schweitzer, Philip A., Handbook of Valves.

[4] Work shop on gate valve CRANE.

[5] J.K. Wang and Steven averitt. Root cause analysis and Recommendation to eliminate the binding problems with the shutdown cooling system.

AUTHOR BIOGRAPHY

DR GURUDUTT SAHNI (MECHANICAL ENGG) HOD & GENERAL MANAGER OF DEPTT OF DESIGN, DRAWING & DEVELOPMENT LEADER VALVES LTD JAL (PB),CHARTERED ENGG (IEI) INDIA,CORPORATE MEMBER IEI INDIA,EDITORIAL BOARD COMMITTEE MEMBER WORLD ACADEMY OF SCIENCE ENGG & TECH(WASET) & QMS LEAD AUDITOR.

JASPREET SINGH (MECHANICAL ENGG) BTECH MECH FROM DAV INSTITUTE OF ENGG & TECH. JALANDHAR

TAJINDER SINGH (MECHANICAL ENGG) BTECH MECH FROM DAV INSTITUTE OF ENGG & TECH. JALANDHAR