# *Severe Service Control Valves*

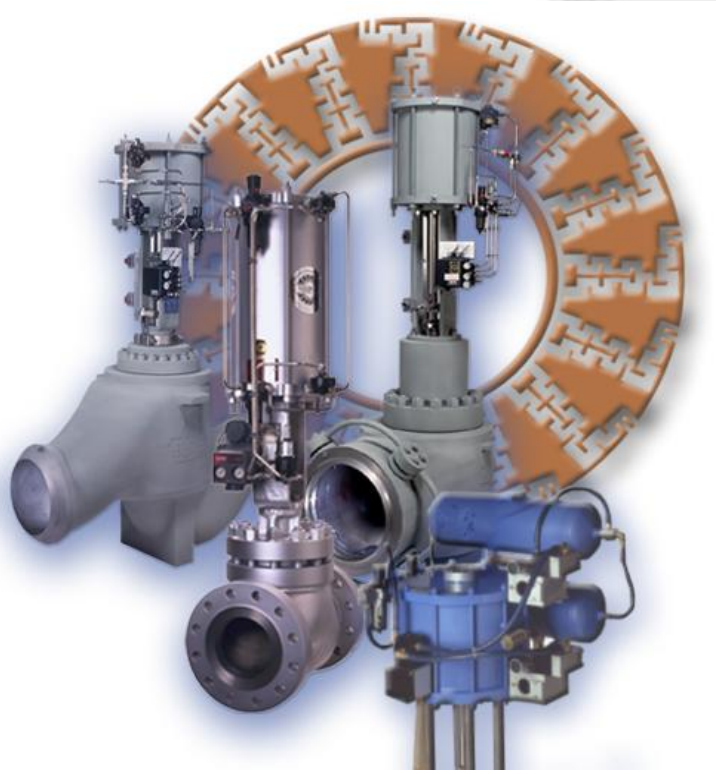
**Ory Selzer**

**Valve Doctor, Power – Americas**

**ods@ccivalve.com**

# Today's Seminar

- Introduction - CCI
- Severe Service Applications
  - Control valve hierarchy
  - Definition of severe service
  - Common applications
- Some Key Parameters
- Severe Service Trim Designs
- Q&A



# Introduction - CCI

- **Founded in 1961 in Southern California**
  - **Purchased by Babcock & Wilcox in 1971**
  - **Sold to IMI plc, out of the UK in 1981**
- **Largest dedicated severe service valve manufacturer in the world**
- **Custom engineered – made to order products**
- **Fossil Power, CHP, Oil & Gas, Nuclear**
- **Global footprint – sales, service, manufacturing, etc.**

Babcock & Wilcox

Bailey

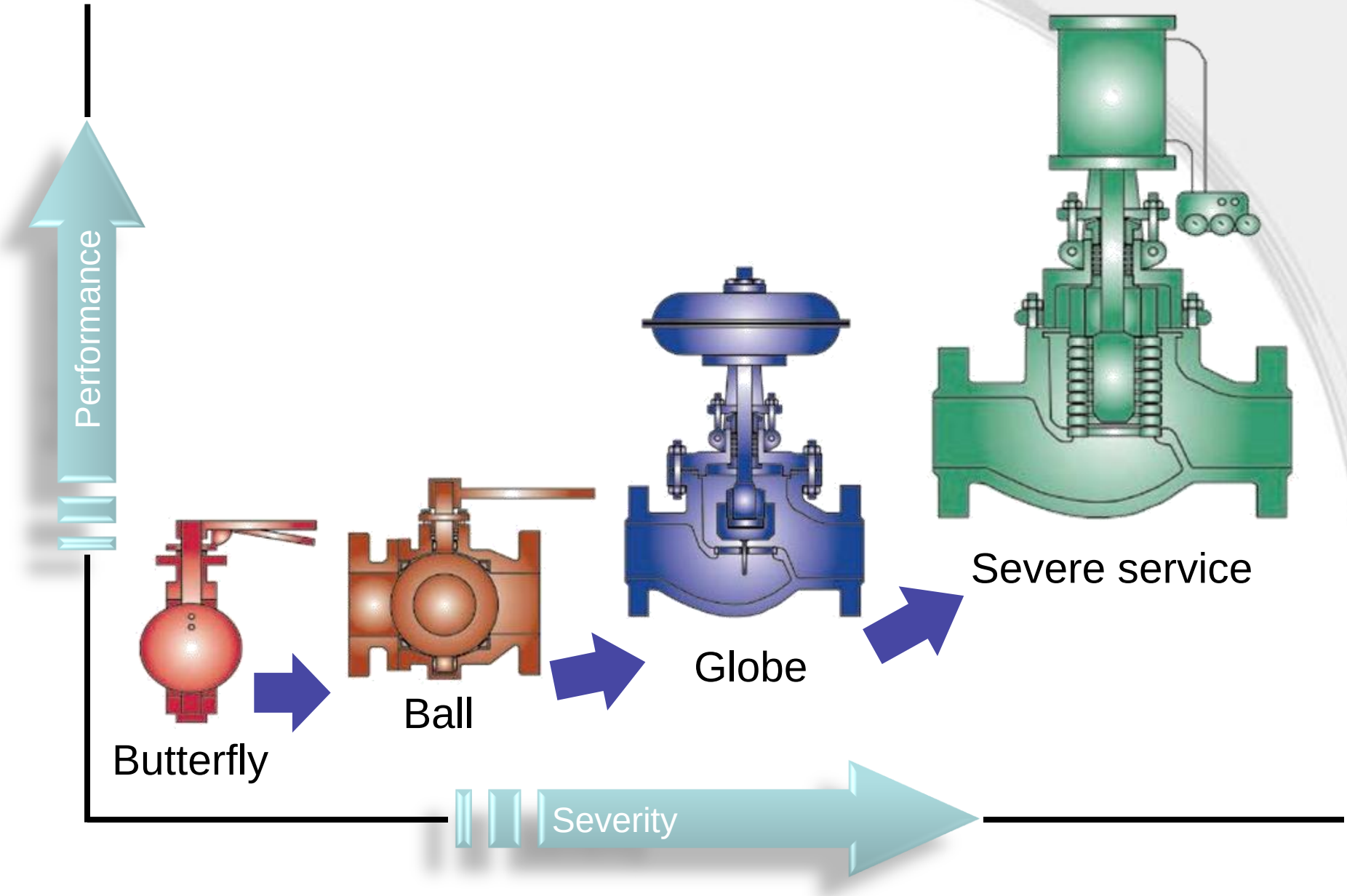
IMI

BTG Valves

STI

FLUID KINETICS

# Control Valve Hierarchy



# Severe Service Definition

- **Cavitation potential exists (Water Valves)**
- **High vibration / noise expected (Steam Valves)**
- **Flashing service**
- **$\Delta P/P1>0.5$**
- **Historical knowledge**
- **Needs continuous maintenance**
- **Plant manager knows about the valve**

Severe Service = High Pressure Drop = High Velocity = ENEMY

# Velocity Related Damage Mechanisms

- **Cavitation damage varies as a 5th to 6th power of velocity**
- **Erosion damage varies as a 2nd to 4th power of velocity**
- **Control valve noise varies as logarithmic with mach**
- **Vibration is caused by excessive fluid velocities & turbulence**
- **Corrosion is accelerated by velocity & fluid turbulence**

# Common Severe Service Applications – Combined Cycle Power Plants

- Main Boiler Feedpump Recirculation
- Start-up & Main Feedwater Regulation
- Turbine Bypass Systems
- Attemperation & Spraywater Control
- Auxiliary Steam
- Vent Valves
- Condensate Recirc valves

# Key Application Parameters

- **Plant type**
  - **Combined Cycle, Supercritical, Sub-critical, CHP**
  - **Cycling, Base Loaded, Peaking, Process Steam**
- **Identify the function of the control valve in the loop**
  - **Flow control, Pressure control, Temperature control, Safety function**
  - **System design and solution: Installation, Piping, Drains, Controls, etc.**
- **Review data sheet and establish operating parameters based on:**
  - **Specified operating conditions**
  - **Extrapolation between specified conditions**
  - **Historical knowledge of the valve application and industry**

# Key Process Parameters

- **Pressure Drop**
  - High pressure drops can lead to high velocities - multi-stage pressure letdown is required
  - High velocities can lead to cavitation in water service and noise in steam service when left uncontrolled
- **Rangeability**
  - Many applications require high rangeability for process control, i.e. Drum Level Control and Spraywater control
  - Valve trim design, capacity and stroke length have a dramatic impact on rangeability
- **Temperature**
  - High temperature designs require higher strength materials; CrMo, Inconel, Surface treatments
  - Adding spraywater introduces thermal stresses – full system must be reviewed and designed together to provide proper control and protection from thermal fatigue
- **Noise Requirements**
  - High pressure letdown in steam valves can create high velocities leading to noise levels near >110 dBA
  - Steam kinetic energy must be controlled using mult-stage pressure letdown to reduce noise and vibration and keep plant operating safely

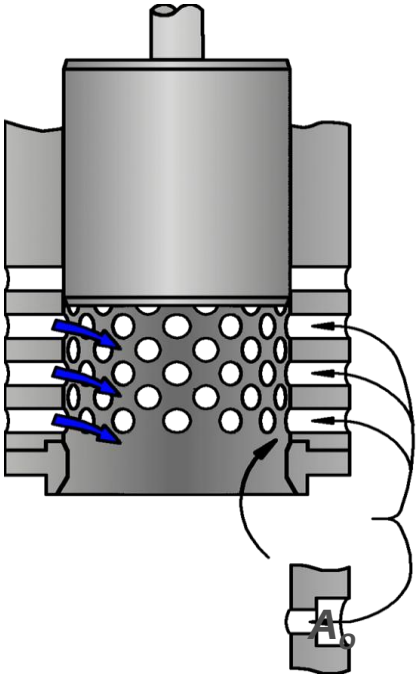
# ISA guide: Velocity Control Limits

Trim outlet kinetic energy criteria

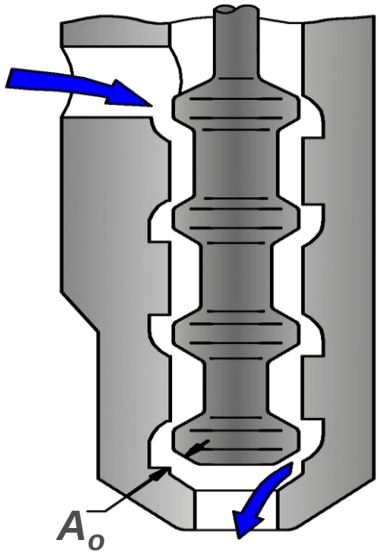
| $KE = \frac{\rho V^2}{2g_c}$ Service conditions | Gas / steam kinetic energy criteria | Equivalent liquid / water velocity |
|---|---|---|
| | psia | ft / s |
| Continuous service single phase fluids | 70 | 100 |
| Cavitating & multiphase fluid outlet | 40 | 75 |
| Vibration sensitive system | 11 | 40 |
| Intermittent duty | 150 | - |

# Severe Service Control Valve Trims

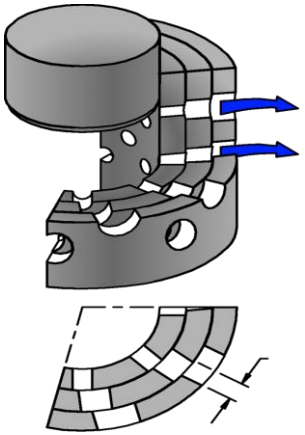
Single-Stage
Multi-Path



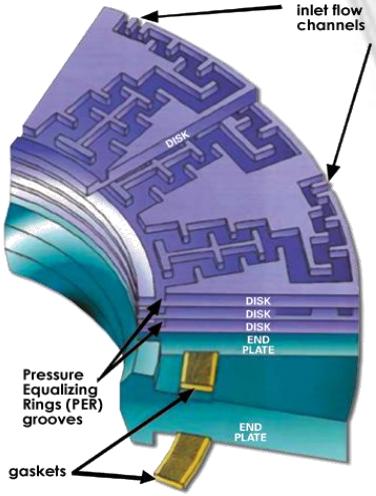

Multi-Stage
Single-Path



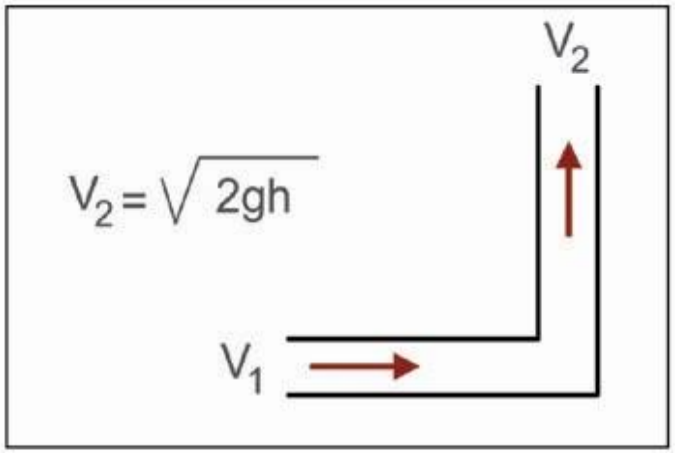

Multi-Stage
Multi-Path



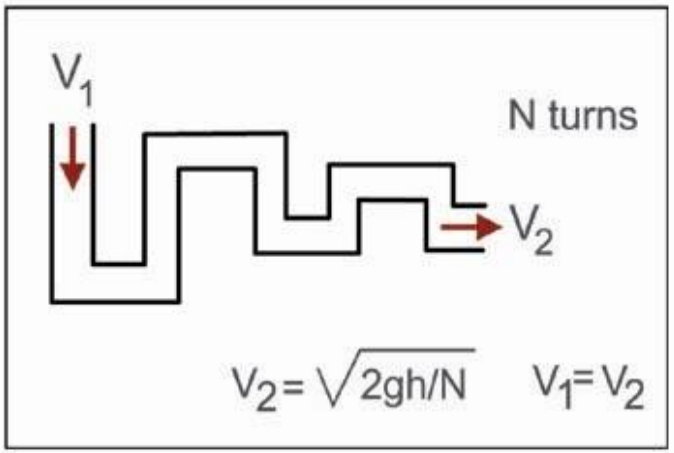

Torturous Path
DRAG®



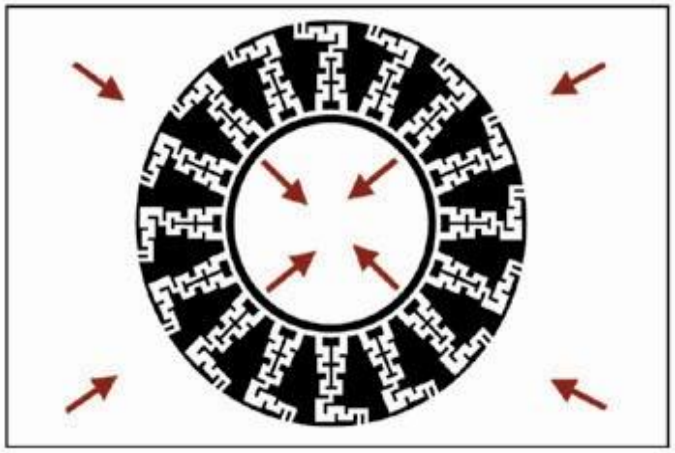
# DRAG® velocity control principle



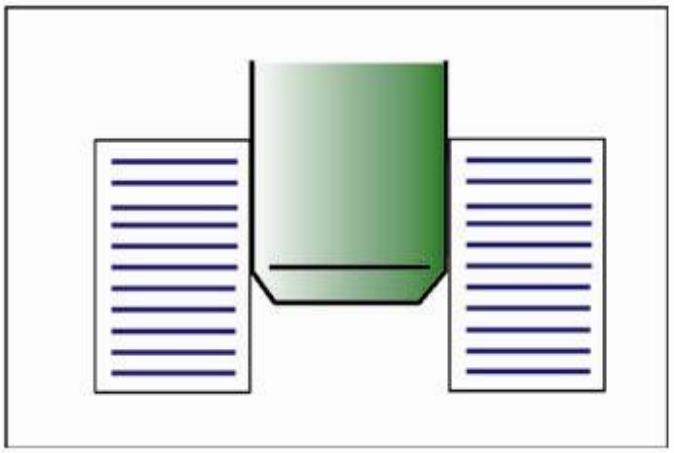

Single stage pressure reduction




Multi stage pressure reduction



Multi path multi stage disk



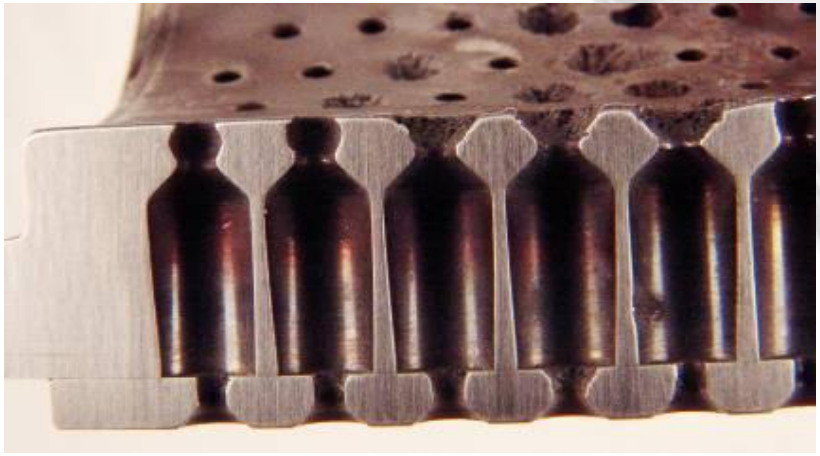
DRAG® disk stack

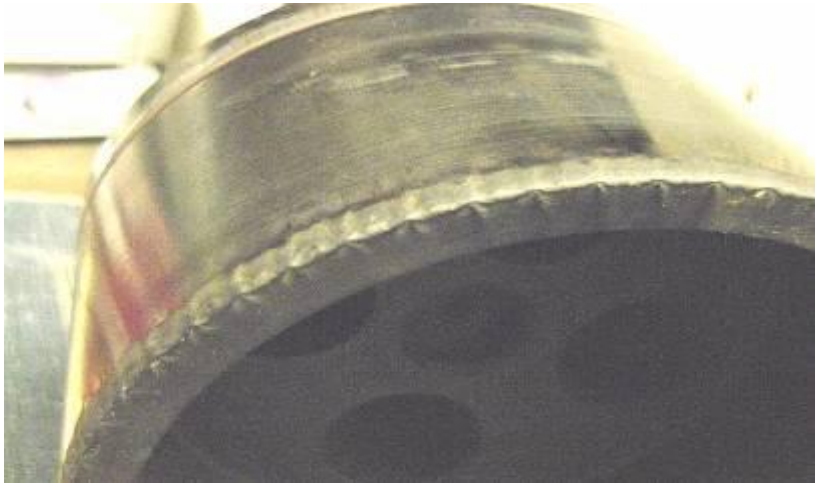
# What happens when not enough stages are used?

| Number of stages | ΔP, psi | | | |
|---|---|---|---|---|
| | 500 | 1400 | 2300 | 4100 |
| | ft/s | ft/s | ft/s | ft/s |
| 1 | *155* | *259* | *332* | *441* |
| 3 | *103* | *172* | *220* | *293* |
| 4 | < 100 | *148* | *190* | *253* |
| 8 | < 100 | < 100 | *121* | *161* |
| 12 | < 100 | < 100 | < 100 | *113* |
| 16 | < 100 | < 100 | < 100 | < 100 |

**Assumes ambient temperature water**

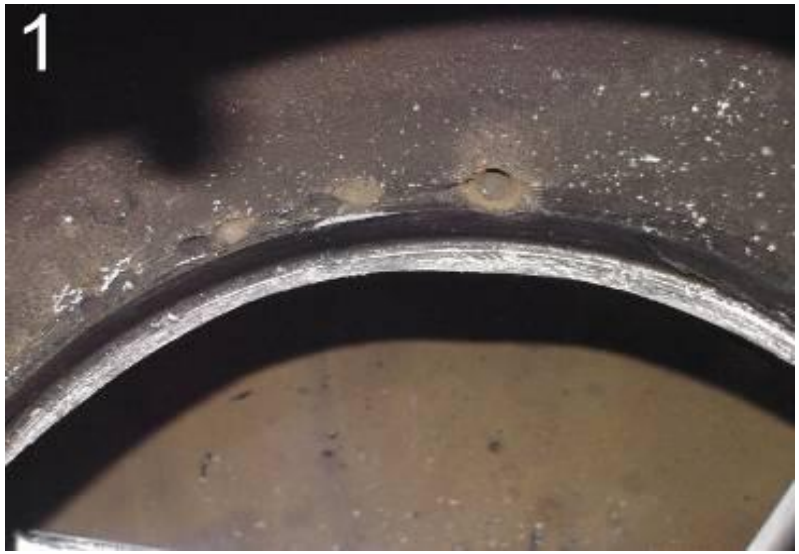
# Cavitation Damage – Not Enough Stages

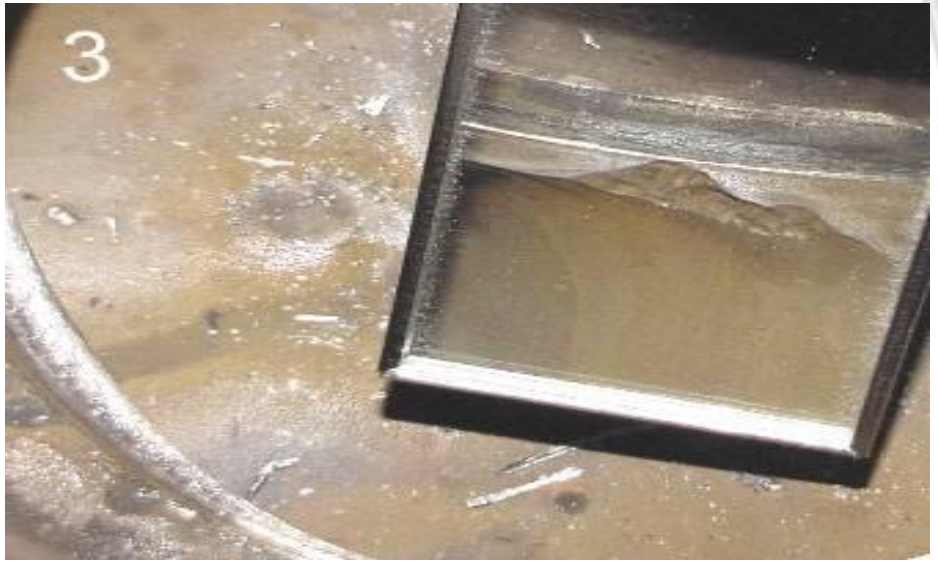




## *Application – BFP Recirculation, 1700 psid*

# Erosion in HP Feedwater valve



# Summary

- Though small in number, severe service applications pose the highest challenges in the steam and water systems
- Each application should be reviewed and treated appropriately based on key application and process parameters
- Once severe service applications are identified the correct valve design needs to be applied to assure proper valve and plant performance
- ISA guidelines for sizing control valves are a great starting point: “Control Valves – Practical Guides for Measurement and Control” published by ISA