Master Flo

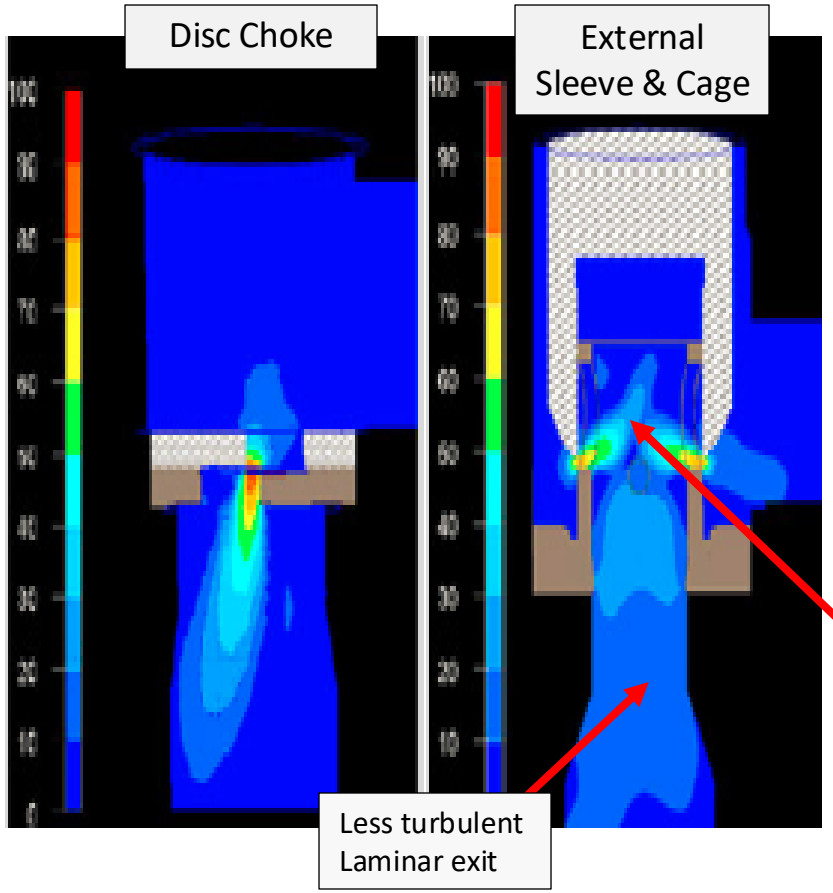
Water Midstream
Why Master Flo?

DISC CHOKE ISSUES
Cavitation & Jetting

Commonly Used SWD Solutions
Disc Chokes [Taylor, Cyclonic]

Poor Pressure Recovery
Leads to Cavitation

Improper Metallurgy Challenges
MF: TC5 and SSt, always right choice
Cyclonic: Carbon Steel is base option for Stem Driver & Disc Carrier
Easy to spec wrong materials = Failures!!

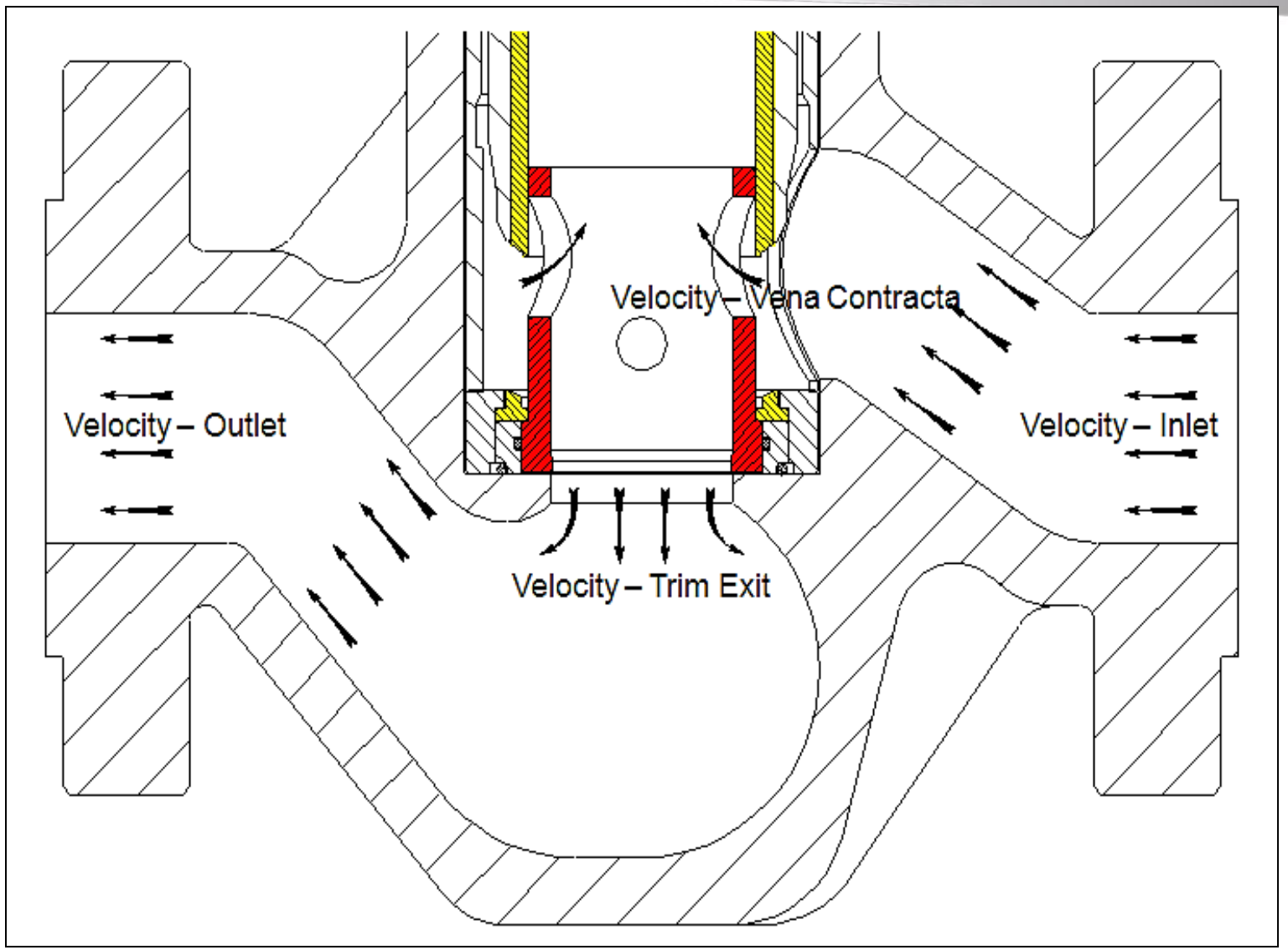


Dynamic Operating Requirements
Change over time = Washing
Moving more or less water

Fluid Jetting
Due to Improper Sizing
Leads to Body Breach

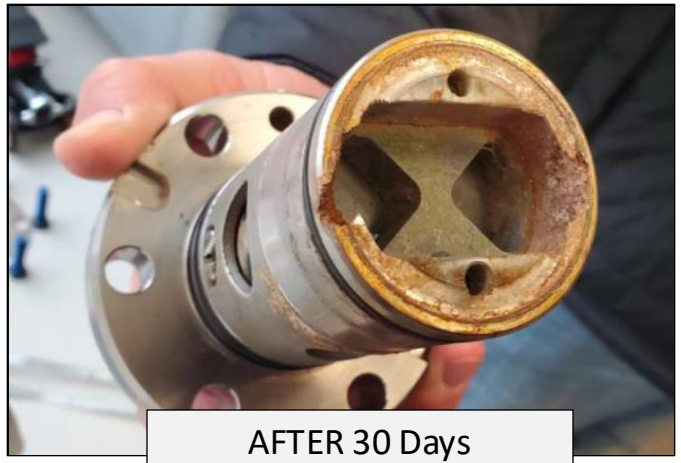
MASTER FLO BODY

Inline Body

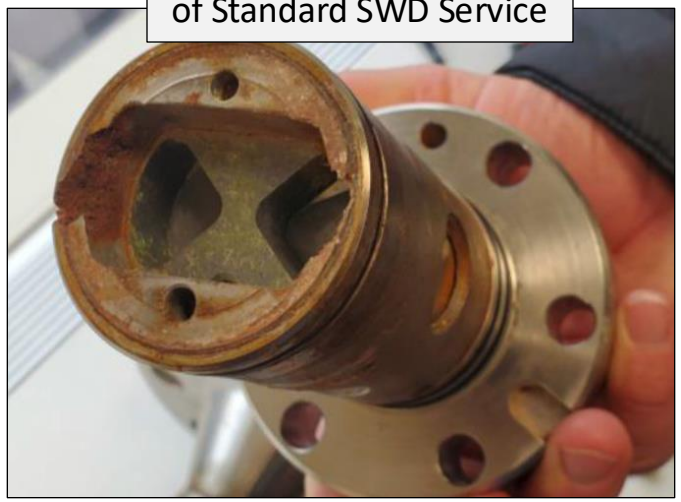


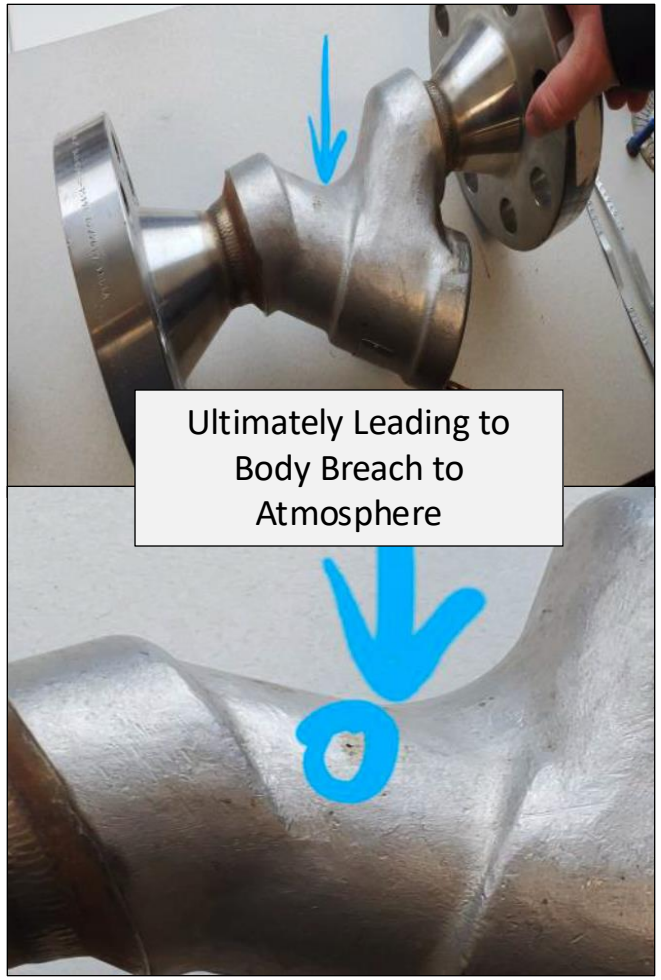
DISC CHOKE ISSUES

Cavitation & Jetting Results



AFTER 30 Days
of Standard SWD Service





Ultimately Leading to
Body Breach to
Atmosphere

Cyclonic Disc Driver
Damaged Teeth

Classic Disc Choke
Damage

MASTER FLO V DISC CHOKES

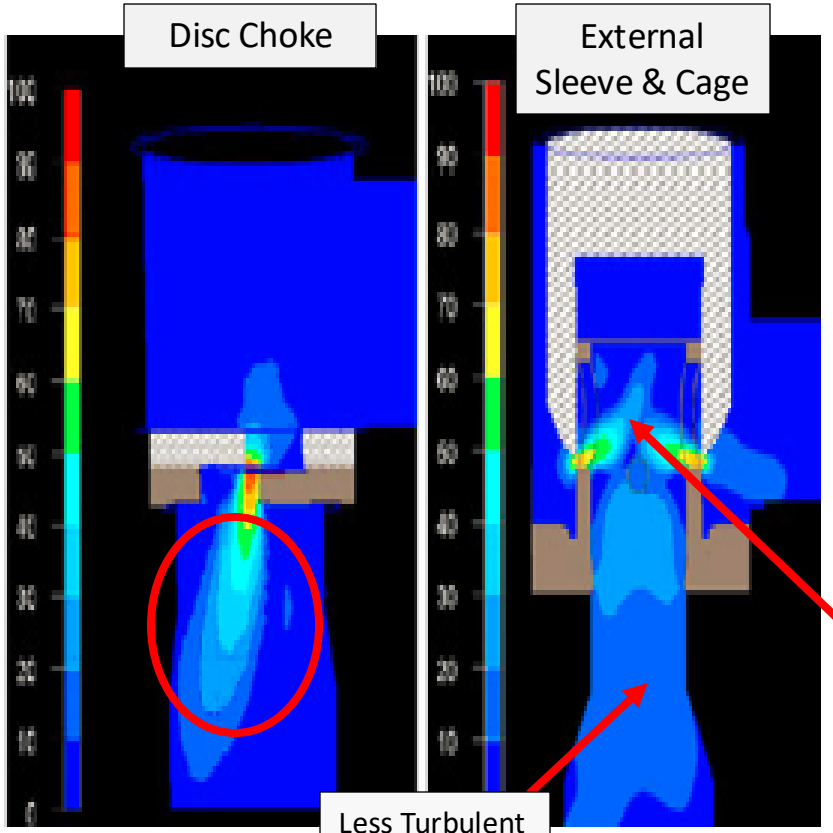
Protecting H Pumps + Better Operations

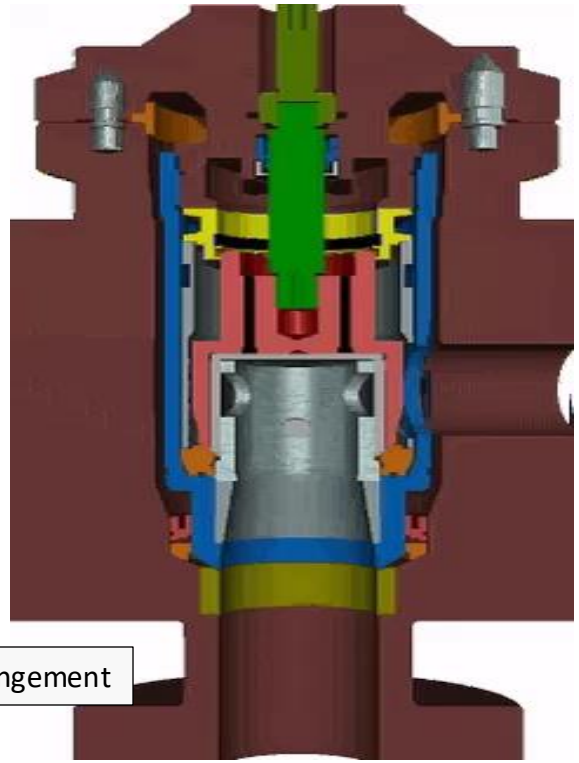
Supports Broader Range of Operation
Versus Cyclonic or Taylor Disc Chokes
30-70% Rangeability v 0-100% w Master Flo
Based on External Cage & Sleeve w Impingement
More Flexible Range of Flow Conditions

Fluid Impingement
Superior Pressure Recovery
Ideal Flow Characteristics
Reduces Cavitation!!

Centralized Fluid Turbulence
Directed towards Center of Trim
Directed away from Choke Body
Eliminates Outlet Bore Jetting!!

More Efficient Pump Operation
Keeps H Pump on Efficiency Curve





MASTER FLO
Water Midstream Pictures

MASTER FLO
Water Midstream Pictures

VANZANDT CONTROLS, LLC
Eagle AUTOMATION

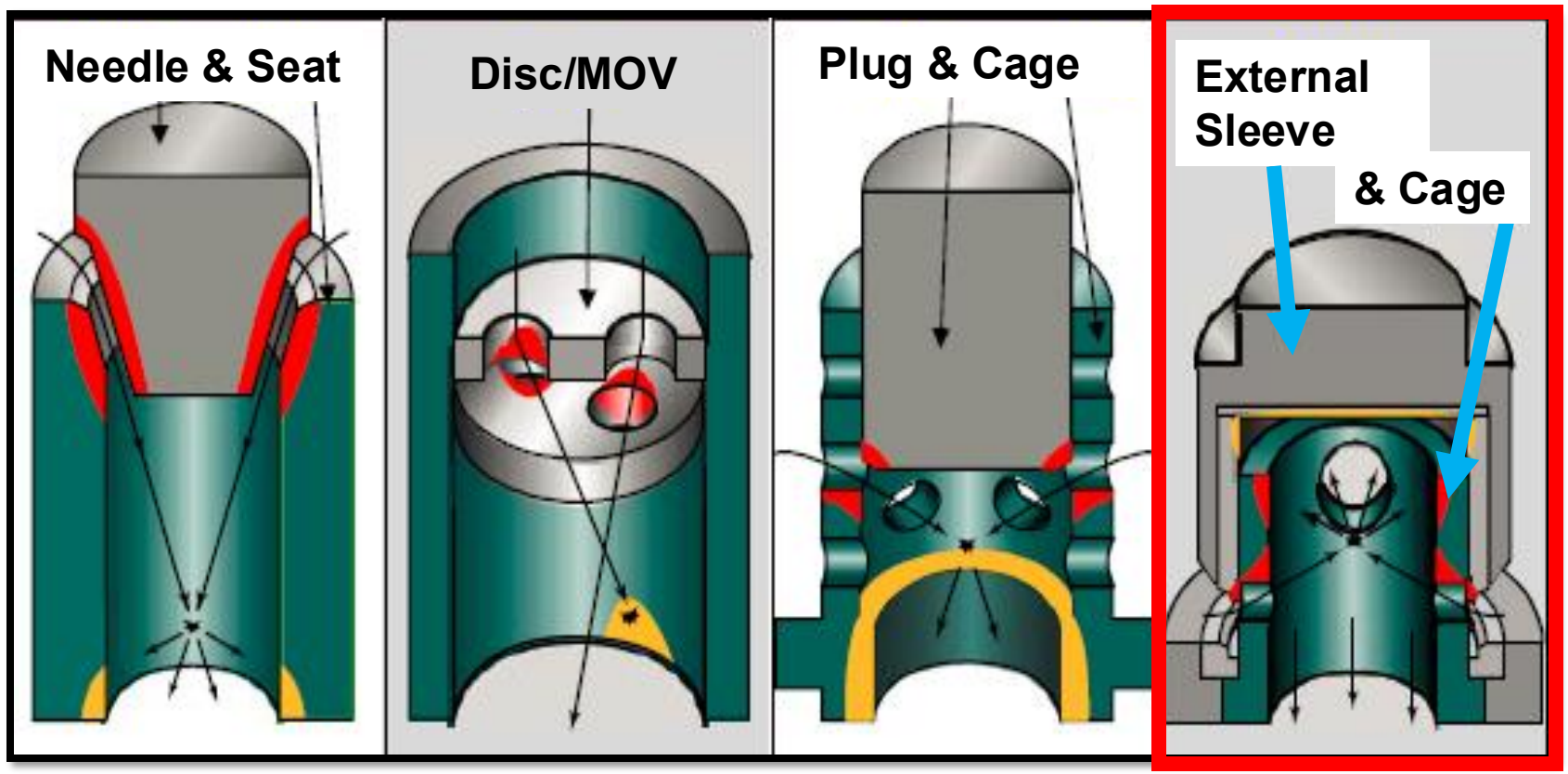
Master Flo

VANZANDT CONTROLS, LLC
Eagle AUTOMATION

- Product Overview
- Haynesville Choke
- Manual Chokes vs Auto Chokes
- Back Pressure H Pump CV Produced Water
- Extreme Erosion Solution

PRODUCTION CHOKES FUNDAMENTALS

Four Primary Trim Designs



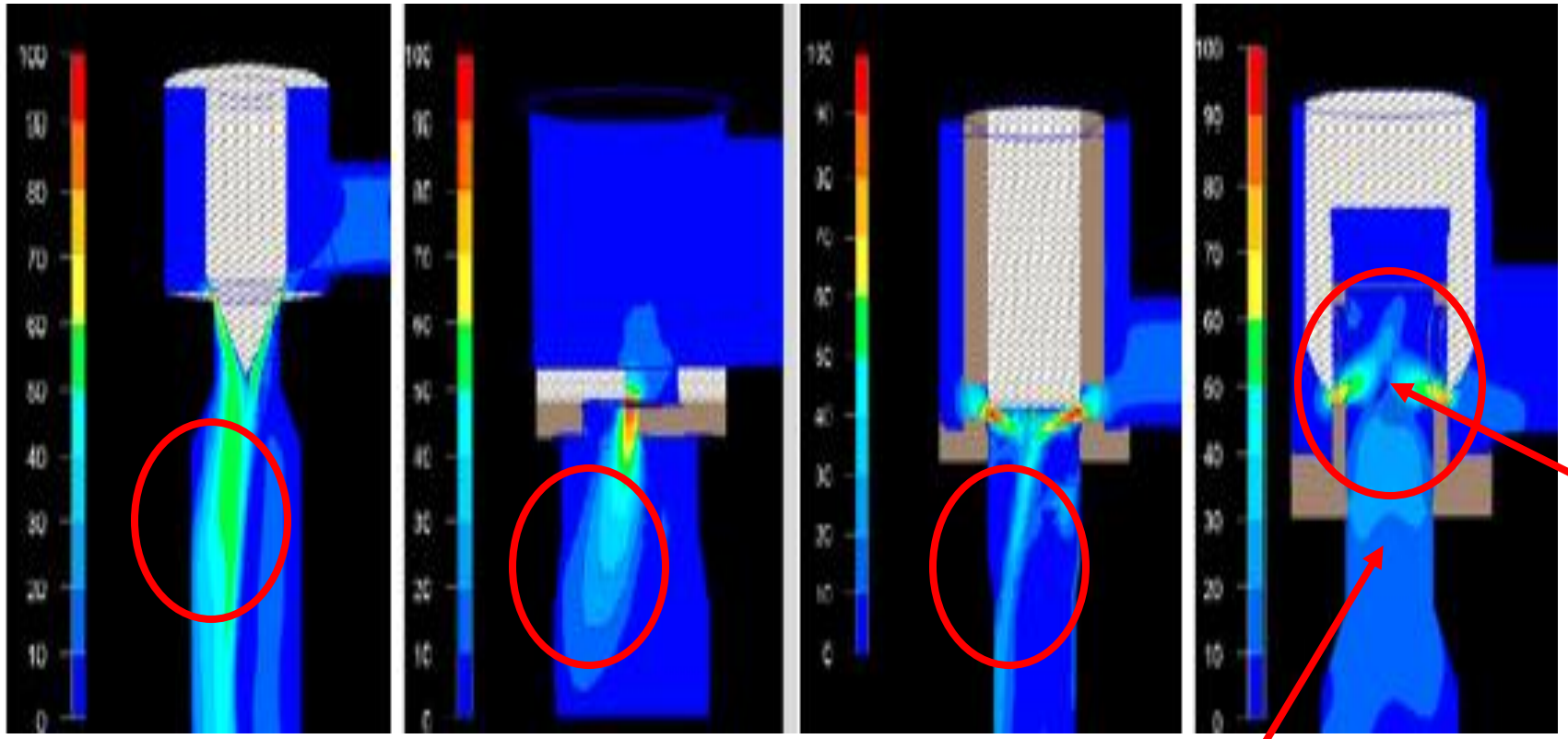
c.1925	c.1950	c.1975	c.2000

PRODUCTION CHOKES FUNDAMENTALS

Fluid Jetting Comparison

Erosion Tolerance →

Needle & Seat	Disc/MOV	Plug & Cage	External Sleeve & Cage



Fluid Impingement

Less Turbulent & Laminar Exit

NEEDLE & SEAT CHOKES

Low Cost, Significant Challenges

Not Pressure Balanced
Unbalanced Trim requires much **more Torque** to Operate

Extreme Torque Requirements
Directly proportional to Inlet Pressure
Can become Extreme in applications where:
- High DP
- High Inlet Pressure

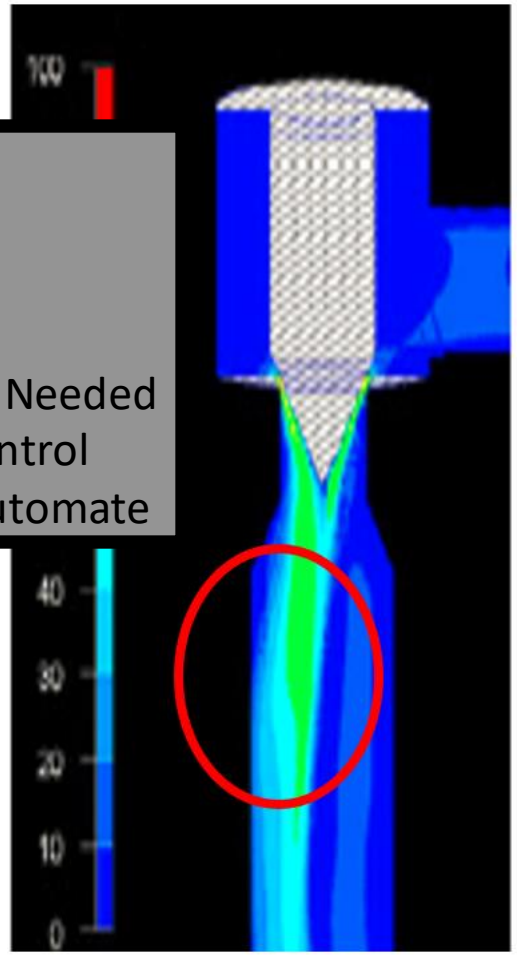
Shearing Valve Stems is Common
In Automated Applications
After adding Safety Factor, might exceed MAST Value
- Maximum Allowable Stem Torque

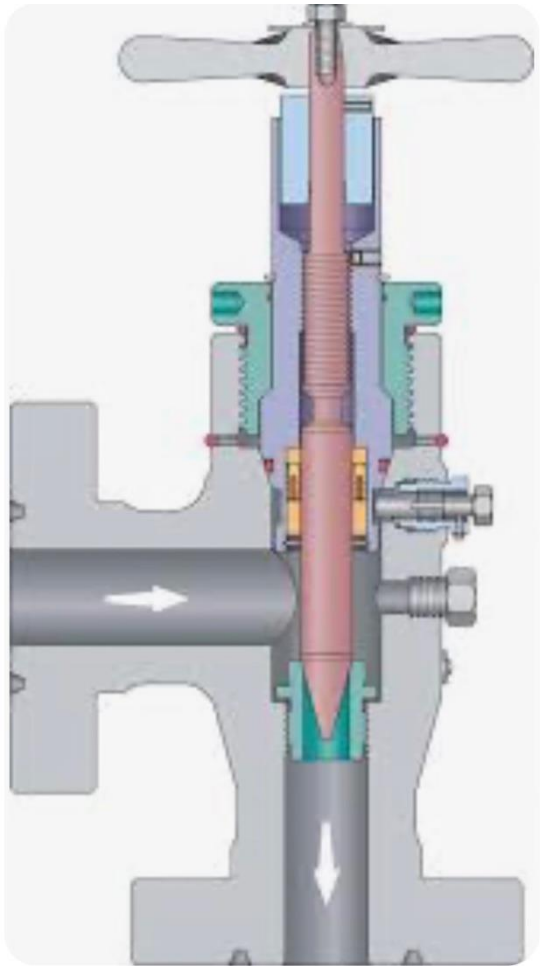
Serious Safety Concern
If the **Stem Shears below the Stem Packing/Sealing area**
- Process media **might be released at high velocity**
- Towards surrounding equipment or personnel

Highest Market Share
Needle & Seat
60-70% Market Share
Low Cost
High Maintenance Effort Needed
Damaged Seat = Poor Control
Not Recommended to Automate

Can't Automate
Too Difficult to Control

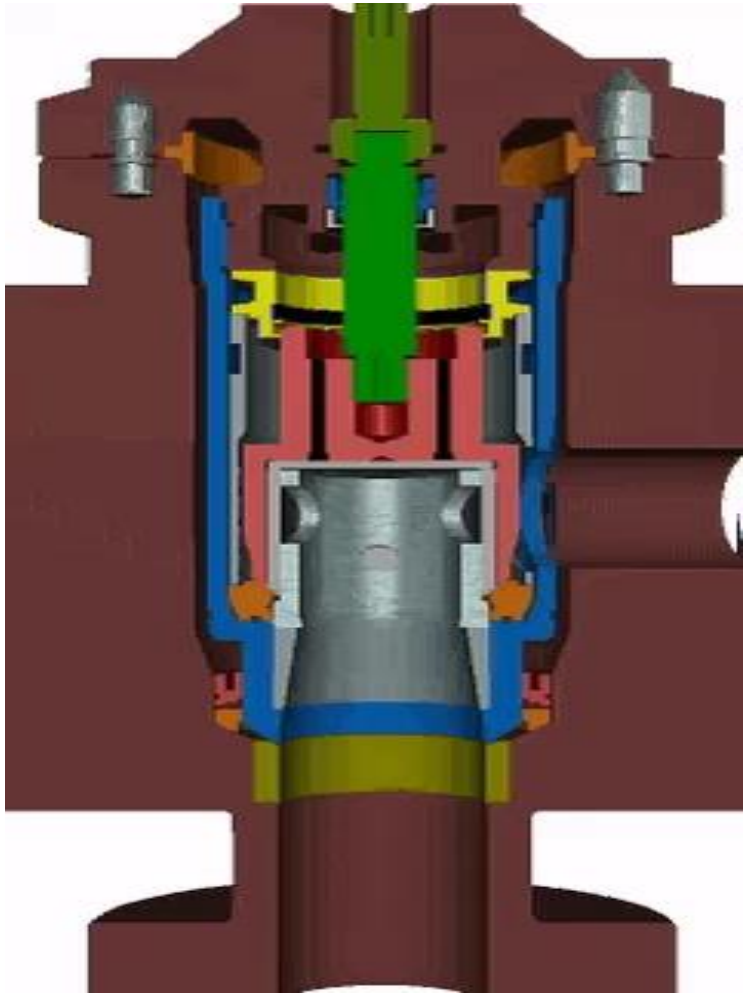
Not Robust
Easy Erosion





UNDERSTANDING WHAT HAPPENS WITHIN THE VALVE

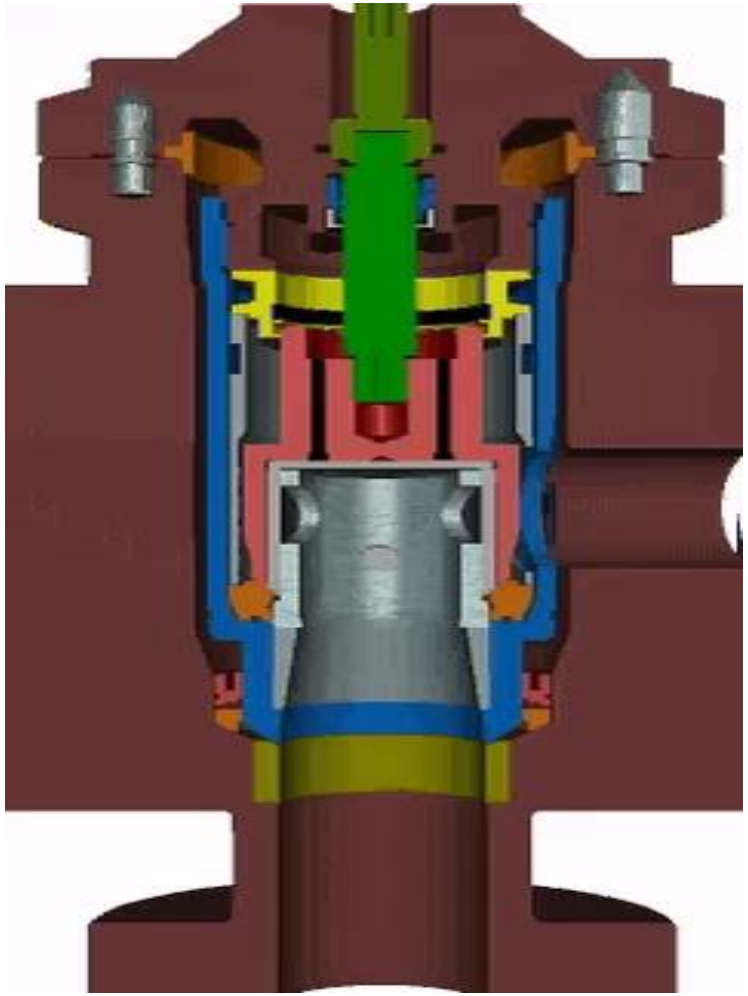
Sequence of Events



1. **Process Flows FROM Inlet Bore INTO Body Annular Space**
2. **Valve "Breaks Seat" & Begins to Rise**
   Stems rises thru the Deadband
   15-30% of Travel
3. **Small Control Ports are Slowly Uncovered**
   Lower end of Cv is now accessible
4. **Larger Control Ports are Uncovered**
   Remaining Cv is available
5. **Valve Closes**
   Shut Off Valve & Seat Face are Protected
   From Upstream Increased Velocities
6. **Valve Returns to Class 5 Shutoff Position**

UNDERSTANDING WHAT HAPPENS WITHIN THE VALVE

Key Attributes



Valve is Balanced

Via Red External Sleeve & Yellow Balancing Sleeve
Communication Ports at Top
Reduces Actuation Demands
Unbalanced Option for Smaller Sizes

Retaining Sleeve Protection

Blue Barrier
Holds Trim in place
Protects Body from Process

Fluid Energy Reduction

Impingement: Process is Used Against Itself
Fluid is Directed Up into Hardened Sleeve
Happens during Steps 3 & 4

UNDERSTANDING CV VERSUS BEAN SIZE

Actual Versus Max Positive Equivalent

MF has higher Cv
Per Same Size v other ES&C Chokes

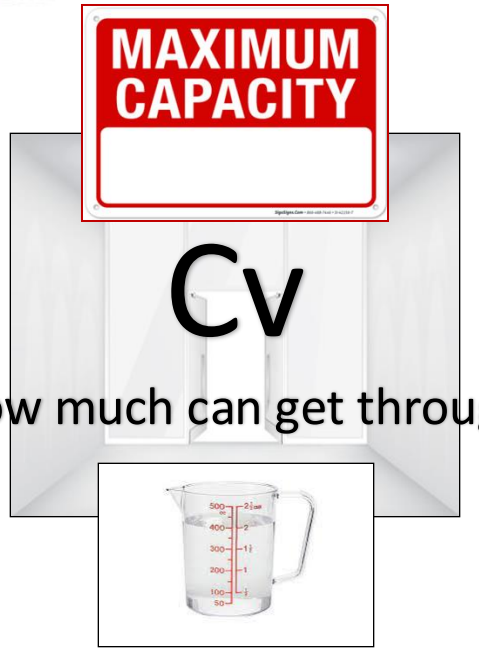
MAX Positive Equivalence
Industry Standard
Based on Positive Fixed Bean Choke

ACTUAL Positive Equivalence
MF Bean
It's Different!!

Valve Size	MAX Positive Equivalence Bean Size	ACTUAL Positive Equivalence Bean Size	MAX Cv
P1	50	58	14
P2	68	81	27
P25	88	103	45
P3	120	137	83
P35	150	179	129
P4	189	216	205
P5	228	265	300
P6	264	304	400
P8	349	450	700
P10	417	490	1000

UNDERSTANDING VALVE SIZING

Cv Versus Bean Size



"How much can get through"

Cv
Valve "FLOW" Coefficient
Universal Measurement of **Volume**
1 Cv = 1 USGPM with a Pressure Drop of 1 psi @ 68 deg F

Bean Size [BS]
"Orifice Diameter" in 64th of an Inch
Measurement of **Size**
An Orifice of a 2" inch diameter = Bean Size of 128/64th

"The size of the port"

WHY CHOOSE MASTER FLO CHOKES

Master Flo Pro‘s & Con‘s Versus Other ES&C Chokes

Pro’s

“Floating” Cage & Seat
No Special Tools Needed
Low Maintenance
Tighter Tolerances
0.2 Cv Clearance Flow
Centered & Self Aligning
Less Lateral Movement & Vibration

Class 5 Shut-Off [Industry Best]

Highest Cv on Market

Tougher MFV 5CB Tungsten Carbide
Versatile Body & Trim Configs

Pressure Balanced Design
Reduces Operating Torque

Master Flo

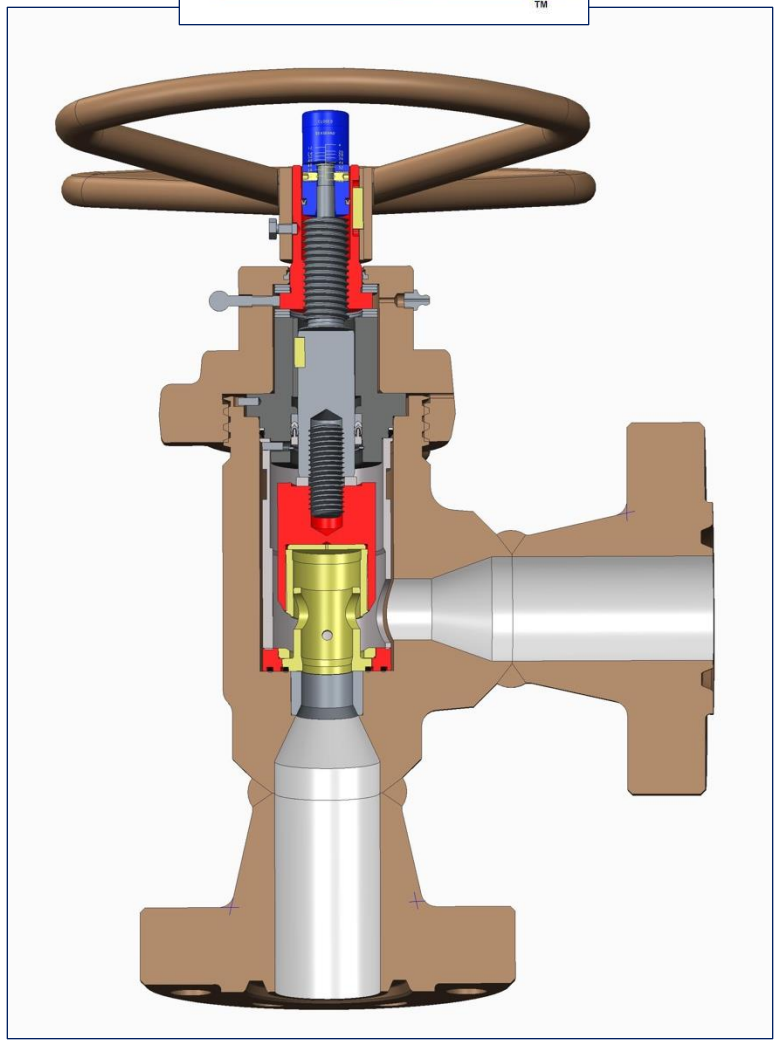
Con’s

“Over-Engineered” Reputation
Value Perception/Price Point
High Grade TC isn’t cheap

Unique Design = Customer Learning Curve
Dissimilar to Needle & Seat

WHY CHOOSE MASTER FLO CHOKES

Master Flo's Superior Design



Superior SERVICEABILITY

No threaded, wetted parts
Retention Sleeve [Floating Alignment]
Three Piece Trim
    External sleeve, Cage, and Seat
No special tools required

Superior CONTROLLABILITY

Two row, four port nozzle for highest resolution
Patented Equal % trim [Cv tables, Accuracy]
Dead band first 30% of total travel
Minimized clearance & tolerances
Easily balanced

Superior PERFORMANCE

Patented Equal % trim design
Reduced velocities
    Hydrostatic restriction
Class 5 shutoff
Superior Tungsten Carbide
Superior body and outlet protection

WHY CHOOSE MASTER FLO CHOKES

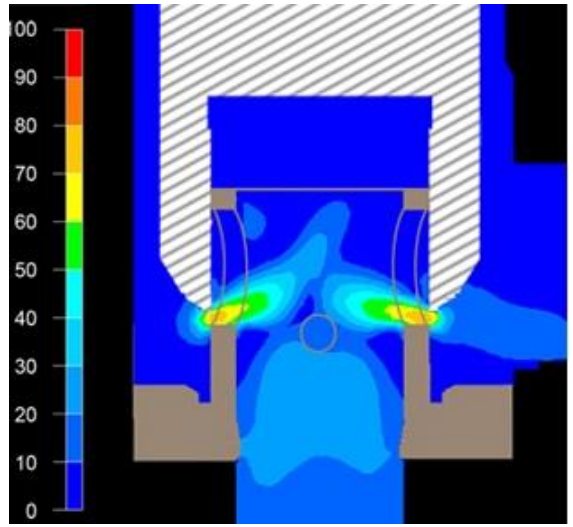
Velocities Within a Master Flo Choke

ORIFICE Velocity
Tungsten Carbide Trim
Allows high acceptable velocity
Typical Hardness: RA 94

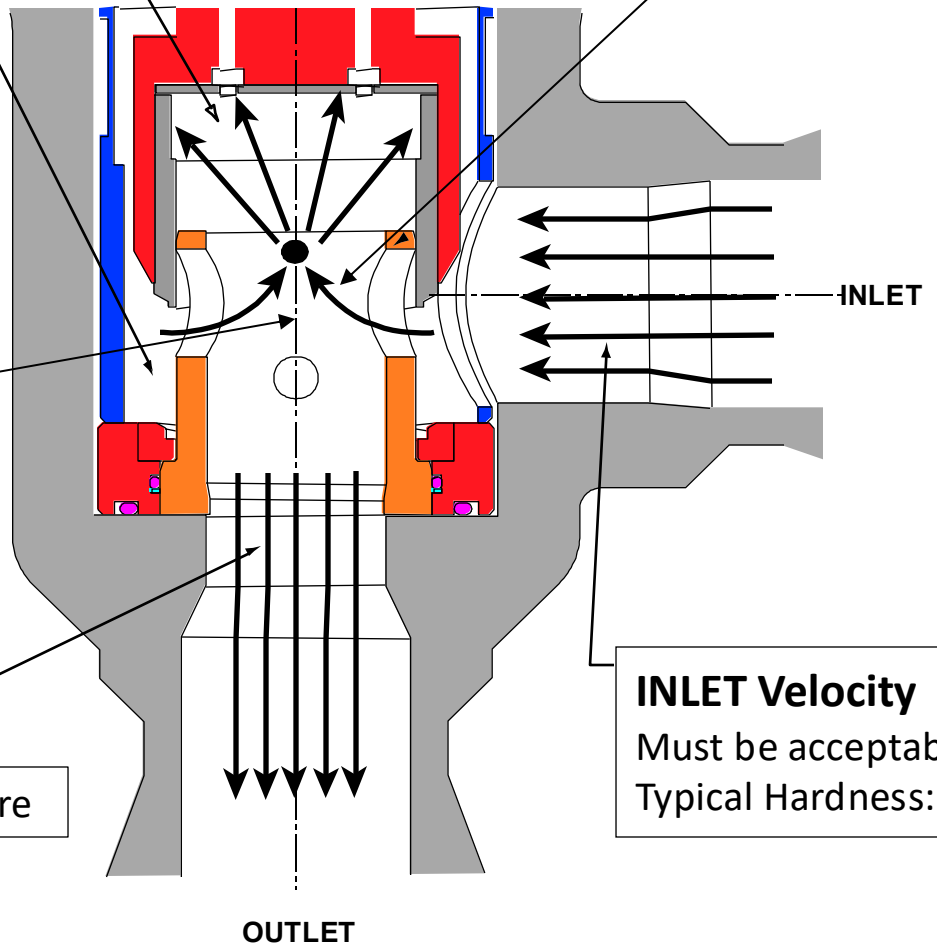
BODY Velocity
Must be acceptable for alloy or SSt material
Typical Hardness: Rc 22

Fluid Energy Absorbed

Velocity increases
Pressure decreases
Temperature decreases



Fluid Impingement
Hydrostatic Restriction
Pressure Stabilizes
Flow Stabilizes



TRIM EXIT Velocity
Must be acceptable for alloy or SSt material
Typical Hardness: Rc 22

Downstream Pressure

INLET Velocity
Must be acceptable for alloy or SSt material
Typical Hardness: Rc 22

Upstream Pressure

WHY CHOOSE MASTER FLO CHOKES

Deadband & Class 5 Shutoff

Fine Flow Control
During full range of travel

Restrict Liquid Flow
And particulate flow
During 1st 30% of travel

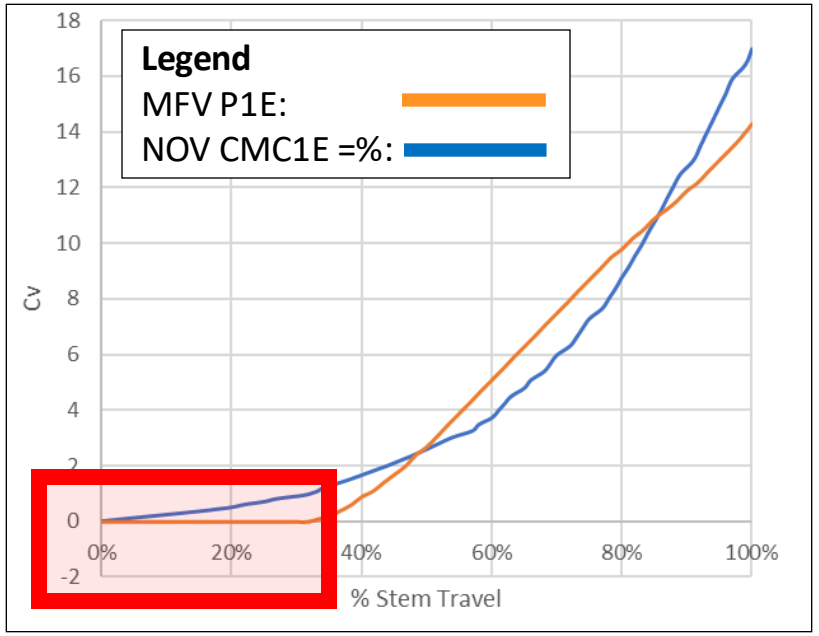
Minimize Flow
During seating & unseating of the valve

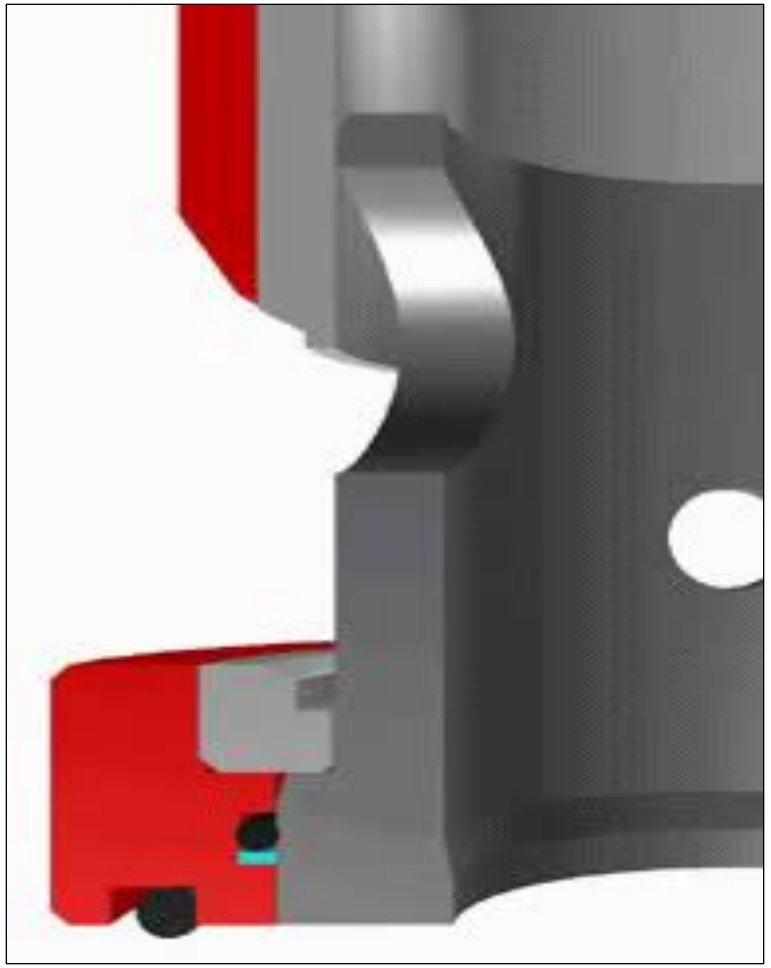
Minimal Bypass
Due to right tolerances
With “floating trim” design

Keep Seat Faces Away
From higher velocities at VC

Minimize Erosion to Seat Face
To maintain Class 5 shut off

Variety of Materials for Seat Face
Tungsten Carbide, SSt, Elastomers



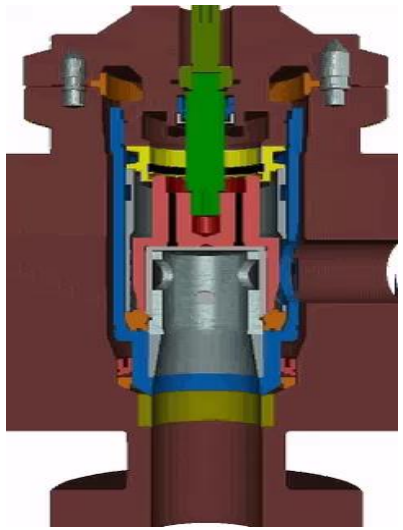


MASTER FLO CHOKES
Value Summary

Better Erosion Resistance
Fluid Impingement

Better Design
Master Flo pioneered the ES&C design
Hold the original patent
Much more knowledge over all other competitors
Only Independent Subsea Valve Manufacturer
~50% more Carbide thickness

Shutoff
Class 5 Shut Off
Throttling surface is separate from Shutoff surface
Protects All Other Wellhead Equipment



Precision Control
Trim design handles fluid better
Dead set control and very tight

Mechanical Deadband
First small part of travel [~20%] = Bypass Flow only
Can Open super slow and still have control
Super tight Tolerance between Cage & Sleeve
Leads to much longer Seal Life
Regular Grade Tungsten Trim doesn't hold up as well
Less Impact Resistant
Master Flo has proprietary blend for Trim

Higher CV [More Thruput]
For equivalent Trim ID
83 CV is standard [P3]

Lower Torque Actuation Needed
Balanced Trim Design [Channels]
Equalizes Pressure across the Sleeve
Requires ~50% less Torque, less Power Draw
Thinner Stem, Less Friction

Video

Less Time to Repair
30-60 Minutes v 4-8 hours
Trim comes out by hand!!
Free Floating Trim Design
"Complete Insert" Format

ACTUATOR OPTIONS
Several Choices

VZLifter
w Valvcon

Rotork

Diaphragm

FOUR CORE APPLICATIONS
Key Applications

Production/Wellhead
Auto & Manual Chokes

Pain Point
Control & Erosion Resistance

Case Study
Manual = Much Longer Lasting
Auto = 85% Flaring Reduction

Competition
NOV, Cameron, Cortec
Needle & Seat

SWD H-Pump
Back Pressure Control

Pain Point
Cavitation/Washing

Case Study
Proven to Eliminate, Mitigate, or Last Several Times Longer than Disc Chokes

Competition
Cyclonic, Taylor, Fisher HPD

Flowback
Choke Manifold

Pain Point:
Downtime

Case Study:
Reduce Flowback Time by ~50%
Minimize Sand Production
Increase I/P & Reach it Faster

Competition
Typically Needle & Seats
Manifolds [2]

Sand Dump
Production & Flowback

Pain Point:
Erosion Resistance

Case Study
Decrease Downtime
Reduce Repair Intervals
Extend Replacement Intervals

Competition
Typically Needle & Seats
Manifolds [2]