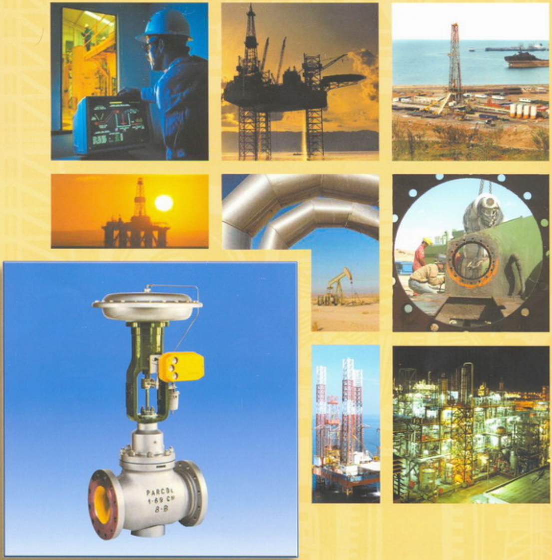
شرکت ملی نفت ایران

شرکت پشتیبانی ساخت و تهیه کالای نفت تهران



آشنایی با شیرکنترل اتوماتیک

مدیریت پشتیبانی ساخت تجهیزات مکانیک، برق و ابزار دقیق

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شرکت ملی نفت ایران

شرکت پشتیبانی
ساخت و تهیه
کالای نفت تهران

آشنایی با شیر کنترل خودکار

مقدمه

کنترل نهایی دریک سیستم کارآسانی نیست. برای شروع طراحی، شما مسؤول تمام مشکلاتی هستید که ممکن است در یک پروسه به وقوع بپیوندد.
در اینجا در مورد خوردگی، سرعت زیاد، تخلخل، یونیزه شدن، سردشدن دما، زیاد شدن دما، سایش و شوک حرارتی صحبت می‌شود. نباید انتظار داشت که بتوان از همه این عوامل مخرب جلوگیری کرد.ولی تا حدودی می‌توان با کنترل مقدار آن از ضایعات احتمالی کم کرد.
یک شیر کنترل ابزار قدرتمندی است برای تغییر دادن مقدار جریان سیال دریک پروسه عملیاتی. حال اگر این ابزار نباشد چه اتفاقی می‌افتد.
وقتی یک شیرکنترل از نظر سایز و کار مخصوصی که انجام می‌دهد انتخاب می‌شود. اولین سؤالی که باید به آن فکر کرد این است که چه مقداری شیر قابل اطمینان است وقتی که زمان کاری آن به پایان رسیده است. این را یک روش جلوگیری از خرابی می‌نامند که خود کلیدی است برای‌رفع موانع و مشکلات.
در حدوداً ۸۰% کاربردها ، این شیر برای جلوگیری از خرابی‌ها مفید است ولی در مقدار باقیمانده زمانی که سیستم دچار اشکال می‌شود نیاز است که شیر باز شود که به آن شیرهای ایمنی می‌گویند.
وقتی برای اولین بار شرکت فوردمستنگ موتوری ۶ سیلندر با گیربکس سه سرعته را که ۱۴۰ مایل در ساعت سرعت داشت ارائه داد نشان دادن کیلومترشمار ۱۴۰ مایلی به آن معنا نیست که بتوان با حداکثر سرعت حرکت نمود به طریق مشابه یک کنترل ولو کلاس ۶۰۰ که برای فشار بالا طراحی شده نمی‌تواند فشار ۱۴۴۰ پوند را تحمل نماید.
دو نوع شیر کنترل وجود دارد. گردشی (Rotary) و خطی (Linear) نوع خطی از قبیل شیر کروی و شیر دروازه‌ای، شیر دیافراگمی و ...
نوع گردشی از قبیل شیرتوپی و شیر پروانه‌ای
هر کدام از این نوع شیرها کاربرد و ساختمان خاص خود را دارند.

شیر کنترل خودکار

(Automatic control valve)

تعریف: شیر خودکار دستگاهی است که در مسیر جریان قرار می‌گیرد و برای تنظیم جریان به کار برده می‌شود. این دستگاه ممکن است با نیروی برق، هیدرولیک و یا هوای فشرده، کار کند. اکثرشیرهای کنترل خودکار به وسیله هوای فشرده کار می‌کنند که به آن شیرهای خودکار نیوماتیک می‌گویند و به علت استفاده از فراوان آن در صنعت اهمیت خاص دارد.

چند اصطلاح

Self operated control valve ـ شیر کنترل خودکاری است که مستقیما به وسیله فشار سیال تحت کنترل کار می‌کند، یعنی فشار سیال تحت کنترل مستقیما به دیافراگم شیر متصل است.

Back Pressure Regulator ـ شیر کنترل خودکاری است که فشار جریان ورودی (UP-Stream) شیر را کنترل می‌کند.
Reducing Regulator ـ شیر کنترل خودکاری است که جریان خروجی (Down Stream) شیر را کنترل می‌کند.
Valvactor ـ دستگاه تقویت‌کننده‌ای است که فشار بازده کنترلر را به منظور سریعتر و بهتر نشاندن پلاک شیر کنترل خودکار تقویت می‌کند.

نوع کار شیر کنترل خودکار

(Valve Action)

شیر خودکار کنترل بسته به اینکه با فشار وارده بر دیافراگم باز و بسته کند. اصطلاحاً Air to open (A.T.O) و (A.T.C) Air to close گفته می‌شود و انتخاب هر یک بستگی به جنبه‌های ایمنی ماده تحت کنترل و نوع کنترل دارد.
مثلا شیری که در راه عبور گاز برای سوخت یک کوره قرار گرفته باید از نظر ایمنی وقتی که هوای دستگاه بنا به علتی قطع شد بسته شود که گاز اضافی وارد محفظه احتراق نشده و باعث انفجار و ایجاد خطر نشود. یعنی باید A.T.O باشد و یا بنا به اصطلاح دیگر S.A.F یعنی (SHUTS on Air failure) می‌گویند.
(Valve stroke): مسافتی را که ساقه شیر خودکار از حالت باز کامل تا بسته کامل طی می‌کند کورس شیر می‌گویند.

شیرهای یک نشیمنگاه

Single seated valves

این نوع شیر خودکار ساده و قیمت آن نیز نسبتا مناسب است ولی به علت اختلاف فشار دو طرف پلاگ شیر، پلاک همیشه

تحت دو نیروی نامساوی قرار دارد و اگر فشار ورودی (Up Stream) روی پلاگ باشد و شیر خودکار نیز با پائین‌آمدن ساقه روی نشیمنگاه (Seat) بنشیند در این صورت پلاگ با ضربه و محکم خواهد نشست، ولی البته مسلم است که در این صو رت راه عبور جریان را تقریبا صددرصد می‌بندد.

شیرهای دو نشیمنگاه

Double seated valves

در این نوع شیرها فشارهای نامساوی به طور متناوب رو و زیر پلاگ اثر می‌کنند و بنابر این اثر آنها خنثی می‌شود. یعنی نیروهائی که سعی می‌کند شیر را باز کنند با نیروهائی که سعی می‌کنند شیر را ببندند، هم مساویند. بنابراین ملاحظه می‌شود که نیروی لازم برای بکار انداختن شیر خودکار (Double seat) خیلی کمتر از (Single seat) است.

افت فشار در دو سر شیر خودکار کنترل

افت فشار در داخل بدنه شیر و دو سر دهانه ورودی (inlet port) و دهانه خروجی (outlet port) صو رت می‌گیرد. البته یک عمل اساسی شیر خودکار است که افت فشار ایجاد می‌کند و در غیر این صورت کنترل جریان ممکن نبود. افت فشاری که دو سر دهانه ورودی و خروجی صورت می‌گیرد جهت کنترل جریان است ولی افت فشار داخل بدنه، همانند افت فشار در قسمت‌های دیگر سیستم از قبیل افت فشار در لوله و اتصالها می‌باشد.

تناسب اندازه شیر نسبت به حداکثر مقدار جریان تحت کنترل

اندازه یک شیر کنترل خودکار باید چنان باشد که بتواند ۲۵ تا ۱۰۰ درصد بیشتر از جریان عادی (Normal Flow) که باید کنترل شود را از خود عبور دهد. برای محاسبه اندازه شیر خودکار در نظر گرفتن حداکثر جریان (Maximum flow) و مقدار عادی جریان (Normal flow) باید براساس مقادیر واقعی و حساب شده جریان تحت کنترل باشد و نه براساس حدسیات. اندازه بدنه شیر خودکار بستگی به اندازه لوله حاوی جریان دارد ولی اندازه دهانه‌های ورودی و خروجی(Valve PORTS) با محاسبه تعیین می‌شوند.

جدول زیر مقایسه عدد CV و اندازه شیر خودکار برای اندازه‌های مختلف است

VALVE SIZE IN INCHES	DOUBLE SEATED	SINGLE SEATED	PLUG TYPE
¾	8		%V-PORT AND %PARABOLIC
1	12	9	"
1 ½	28	21	"
2	48	36	"
2 ½	72	54	"
3	100	75	"
4	165	124	"
6	360	240	"
8	640	480	"
10	1000	750	"
12	1440	1080	"

گنجایش و ضریب خروجی جریان

(Capacity And flow co - efficient)

وقتی از ضریب خروجی جریان (CV Value) صحبت می‌کنیم منظورمان همان گنجایش شیر خودکار است یعنی مقدار جریانی که یک شیر کنترل خودکار می‌تواند در یک مدت معین از خود عبور دهد.

تعریف: ضریب خروجی یک شیر خودکار (CV) عبارت است از تعداد گالن آب که شیر خودکارمی‌تواند در یک دقیقه عبور داده و یک پوند بر اینچ مربع افت فشار دو سر دو دهانه لوله ایجاد کند.

برای مثال: اگر شیر خودکاری دارای12 =CV (ضریب خروجی جریان= 12) باشد به این معنی است که می‌تواند در یک دقیقه ۱۲ گالن آب را عبور داده و در حالتی که کاملا باز است یک پوند بر اینچ مربع افت فشار را ایجاد کند. بنابراین ملاحظه می‌شود که CV نمود از گنجایش و اندازه یک شیر خودکار است.

مختصات جریانی یک شیر خودکار کنترل

Valve flow Characteristics

نسبت تغییرات مقدار جریان به تغییرات حرکت شیر خودکار را مختصات جریانی یک شیر خودکار میگویند. این مختصات بستگی به نوع شکل و ساختمان پلاگ شیر کنترل دارد.
شیرهای کنترل خودکار را از نظر شکل و نوع کار پلاگ آنها به طور کلی به سه دسته اساسی تقسیم می‌کنند.

۱ـ مختصات درصد مساوی (Egual percentage char)
۲ـ مختصات خطی (Linear char)
۳ـ مختصات بازکننده سریع (Quick opening char)

مختصات درصد مساوی (E.P.C)

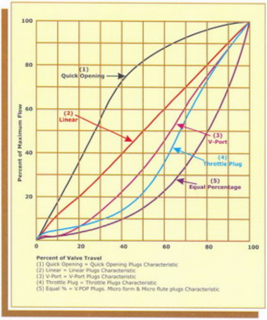
شیر کنترل خودکاری دارای چنین مختصاتی است که به ازا درصد تغییرات مساوی حرکت شیر خودکار درصد تغییرات مساوی در جریان بوجود آورد و این تغییرات متناسب است با مقدار جریانی که درست قبل از ایجاد تغییرات داشته‌ایم. به عبارت دیگر وقتی مقدار جریان کم است تغییرات کم و وقتی جریان زیاد است تغییرات نیز زیاد است و این تغییرات همیشه متناسب است با مقدار جریانی که در حال عبور است.

مختصات خطی (Linear char)

در این نوع شیر کنترل خودکار همیشه نسبت تغییرات حرکت شیر و تغییرات مقدار جریان با هم مساوی‌اند.

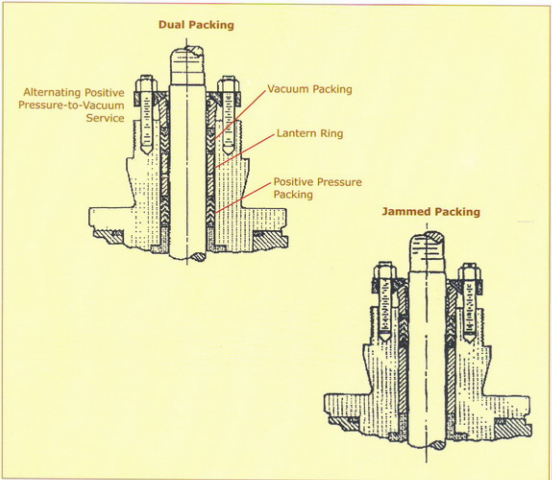
باز کردن سریع (Quick opening char)

این مختصات همانطور که از اسمش پیداست مربوط به شیر خودکاری است که سریع باز می‌کند یعنی کافی است که شیر خودکار کمی باز کند و مقدار زیادی جریان را عبور دهد. یعنی برای حرکت اولیه ساقه شیر خودکار جریان‌های زیاد و برای حرکت‌های نهایی جریان کمتری را عبور می‌دهد. به طوری که در منحنی بعد نشان داده شده است در ۲۵درصد اولیه حرکت شیر خودکار حدود ۴۰درصد جریان و در ۲۵درصد حرکت بعدی ۸۰ درصد جریان را عبور می‌دهد.



آب‌بندی و روغنکاری
(Packing and lubrication)

آب‌بند (Paking) وسیله‌ای است که برای جلوگیری از نشت گاز و یا مایع تحت کنترل از اطراف ساقه شیر خودکار، دور ساقه و در محلی به نام جعبه آب‌بند (Packing box) گذاشته می‌شود و ساقه شیر خودکار هنگام عبور، از داخل چند حلقه (لایه) آب‌بند عبور می‌کند.
معمولا برای روان شدن حرکت از گریس استفاده می‌شود که البته از نشت و نفوذ هم جلوگیری می‌کند. یکی از انواع آب بندهائی که معمولا در شیر خودکار بکار برده می‌شود حلقه‌هایی است از پنبه‌نسوز که با تفلون پرشده Teflon Impregprated (Asbestor و می‌تواند در درجات حرارت تا 400 f بکار رود و برای شیرهای خودکار که مواد نفتی را کنترل می‌کنند نیز کاملا مناسب است. معمولا یک قشر نازک روغنکاری روی پکینگ لاز م است. ولی اگر حلقه‌های یکپارچه صاف بکار برده شود احتیاج به روغنکاری نیست.
تفلون از جنس پلاستیک خشک درست شده و در مقابل مواد شیمیایی مقاوم است و در ضمن می‌تواند در درجات حرارت تقریبا تا ۵۰۰ درجه فارنهایت بکار برده شود.

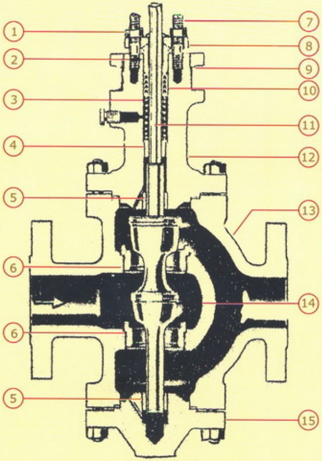


قسمتهای عمده شیر کنترل خودکار

بدنه (Valve body) از یک پوسته فلزی درست شده است و شامل قسمت‌های داخلی شیر مثل دهانه‌های ورودی و خروجی، نشیمنگاه (Seat) و اتصالات لوله ورودی و لوله خروجی است.

Valve trim ـ بجز بدنه و Bonnet (سرپوش) به همه آن قسمت‌هایی گفته می‌شود که با جریان تحت کنترل در تماس هستند.
شکل زیر بدنه و قسمت‌های مختلف آن را به انضمام پلاگ و ساقه شیر نشان می‌دهد.

A double - ported valve, showing nomenclature commonly used.



1. PAKING FLANGE NUT
2. PAKING FOLLOWER
3. PACKING SPRING
4. PACKING BOX BUSHING
5. GUIDE BUSHING
6. SEAT RING
7. PACKING FLANGE STUD
8. PACKING FLANGE
9. YOKE LOCKNUT
10. PACKING
11. VALVE PLUG STEM
12. BONNET
13. VALVE BODY
14. VALVE PLUG
15. BOTTOM FLANGE

عامل محرکه شیر کنترل خودکار

(Valve Actuator)

این قسمت تشکیل شده از یک پوسته، دیافراگم، دیسک، میله (Stem) فنر (Spring) پیچ تنظیم‌کننده کشش فنر، دیسک و صفحه نمودار حرکت و یوک (Yoke)

پلاگ شیر خودکار

(Valve Plug Assembly)

وسیله‌ای است که رابط بین بدنه و قسمت محرکه شیر خودکار کنترل است، میله آن به میله قسمت محرک وصل است و با بالا و پائین شدن می‌تواند روی نشیمنگاه (Seat) شیر خودکار بنشیند و یا از نشیمنگاه جدا شود و بدین طریق راه عبور جریان را بسته و باز می‌کند.

طرز کار شیر کنترل خودکار

(Control Valve Operation)

هوا و یا گاز با فشار تنظیم شده به وسیله کنترلر از طریق سوراخی در بدنه قسمت محرک رو یا زیر دیافراگم بکار برده می‌شود. اگر فشار هوا روی دیافراگم بکار برده شود، دستگاه محرکه را مستقیم (Direct Actuator) شکل ۳ و اگر زیر دیافراگم بکار رود دستگاه را معکوس (Reverse Actuator) می‌گویند. شکل ۴.

در دستگاه محرکه مستقیم فشار هوا روی دیافراگم داده می‌شود. در این صورت دیسک زیر دیافراگم ورودی فنر قرار می‌گیرد. فشار هوای وارده به هر یک باعث می‌شود که دیافراگم رو به پائین و یا بالا حرکت کرده و در نتیجه میله را با خود حرکت دهد. فنر در مقابل نیروی وارده از طرف دیافراگم ایستادگی می‌کند. هرچه فنر قویتر باشد حرکت دیافراگم در اثر فشار هوای داده شده کمتر و هرچه ضعیفتر باشد حرکت دیافراگم به نسبت فشار داده شده بیشتر است.

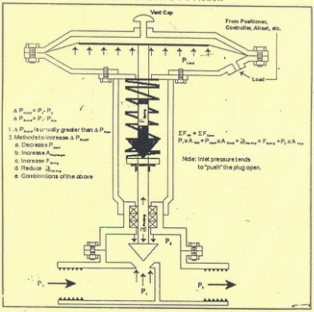
بنابراین میتوان حرکت میله را نسبت به فشار وارده بر دیافراگم با تغییر دادن قدرت فنر کم و یا زیاد کرد.

فشار هوای لازم برای بکار انداختن یک شیر خودکار با فنر قوی بیشتر از فشار هوای لازم برای بکار انداختن همان شیر خودکار با فنر ضعیفتر است. فنر را Range Spring می‌گویند.

فشار وارده بر دیافراگم باعث می‌شود که میله را با خود حرکت دهد. چون میله به پلاگ شیر وصل است بنابراین حرکت میله به پلاگ منتقل شده و پلاک را از نشیمنگاه (Seat) جدا کرده و یا روی نشیمنگاه می‌نشاند.

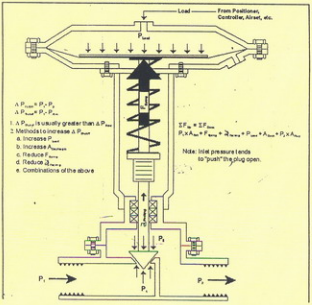
اگر شیر خودکار با فشار وارده بر دیافراگم راه عبور جریان را باز کند شیر خودکار را اصطلاحا Air to Open و یا مختصرا (A.T.O) و اگر فشار وارده بر دیافراگم راه عبور جریان را ببندد شیر را کل Air to Close یا (A.T.C) گویند.

Control Valve ATO-FC Action

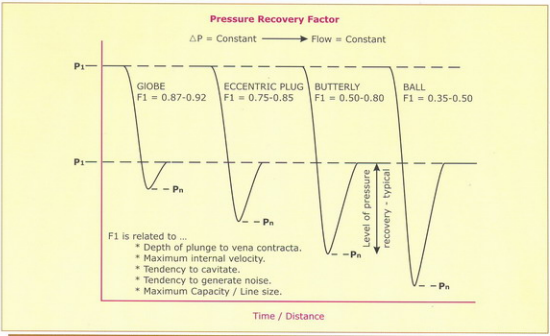


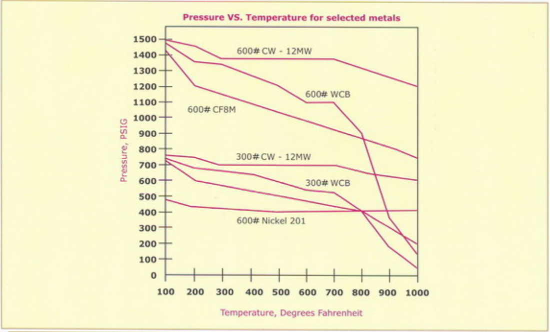
شکل ۴

Control Valve ATC-FO Action



شکل ۳


Pressure Recovery Factor
△P = Constant → Flow = Constant
P1
P1
GIOBE
F1 = 0.87-0.92
ECCENTRIC PLUG
F1 = 0.75-0.85
BUTTERLY
F1 = 0.50-0.80
BALL
F1 = 0.35-0.50
Pn
Level of pressure recovery - typical
F1 is related to ...
* Depth of plunge to vena contracta.
* Maximum internal velocity.
* Tendency to cavitate.
* Tendency to generate noise.
* Maximum Capacity / Line size.
Time / Distance


Pressure VS. Temperature for selected metals
Pressure, PSIG
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
600# CW - 12MW
600# WCB
600# CF8M
300# CW - 12MW
300# WCB
600# Nickel 201
100 200 300 400 500 600 700 800 900 1000
Temperature, Degrees Fahrenheit

(Flow Recovery coefficient)

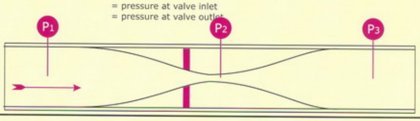
F1= The valve pressure recovery factor, a dimension less quantity. (Measured when valve is not choked.)

$$F1 = \sqrt{(P1-P2)/(P1-PVC)}$$

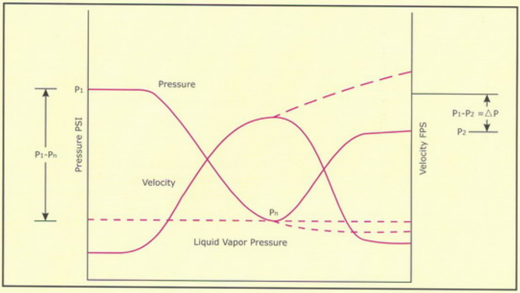
P_1= pressure at valve inlet
P_2= pressure at valve outlet

$\Delta P = P_1 - P_2$

P_n = pressure at Vena Contracta



The vent contracta is the place along the axis of flow, just beyond the orifice, where the jet steam contracts to its minimum cross-sectinal area. Note: It is at point that the velocity is at its highest, and the fluid pressure is at its lowest.



AN INTRODUCTION CONTROL VALVES

CONTROL VALVES DO WHAT THEY ARE TOLD!

Being the Final Control Element in a system is not an easy job. To start with, you are blamed for any and all problems that crop up in the process. You are subjected to corrosion, high velocity, cavitation, flashing liquids, cryogenic temperatures, high temperatures, abrasion, and thermal shock. You are expected not only to throttle along through all this, but most likely, you are also being asked to act as a block valve and shut off tight.

A Control Valve is a power - operated device used to modify the fluid flow rate in a process system. Well, what happens if the power is cut off? when a Control Valve is sized or selected to do a particular job, one of the first questions you should consider is how that valve will respond in the event of a loss of signal or power. This is called its "fail - safe mode" and knowing the fail - safe mode is the key to trouble shooting it.

In most applications (about 80%), it is desirable for valves to fail closed. In other applications, you might want a valve to fail open or fail in place. Safety concerns and process requirements will mandate the fall mode of the valve.

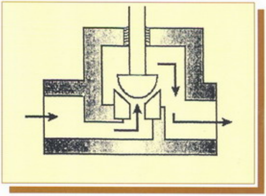
A control valve is only as strong as its weakest link.

When the 1965 Ford Mustang first appeared, it was powered by a 6- cylinder engine with a 3-speed transmission - but it had a 140 m.p.h. (225 k.p.h) speedometer. The fact that it had a 140 m.p.h (225 k.p.h) speedometer did not mean it could actually travel that fast. In the same way, a control valve with a 600# rated valve body cannot throttle and shut off against 1440 pounds of pressure.

There are two basic types of control valves: rotary and linear. Linear motion control valves commonly have globe, gate, diaphragm, or pinch type closures. Rotary - motion valves have ball, butterfly, or plug closures. Each type of valve has its special generic features, which may, in a given application, be either an advantage or a disadvantage.

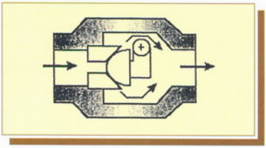
Linear Valve Features

- TORTUOUS FLOW PATH
- LOW RECOVERY
- CAN THROTTLE SMALL FLOW RATES
- OFFERS VARIETY OF SPECIAL TRIM DESIGNS
- SUITED TO HIGH - PRESSURE APPLICATIONS
- USUALLY FLANGED OR THREADED
- SEPARABLE BONNET



Rotary valve features

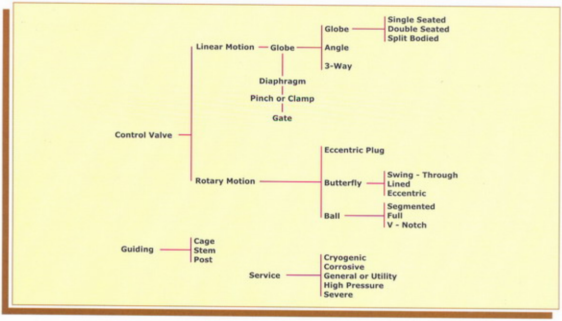
- STREAMLINED FLOW PATH
- HIGH RECOVERY
- MORE CAPACITY
- LESS PACKING WEAR



- CAN HANDEL SLURRY AND ABRASIVES
- FLANGE LESS
- INTEGRAL BONNET
- HIGH RANGE ABILITY

In addition to linear and rotary, control valves are also classified according to their guiding, systems and the types of services they are used in.

Control Valve Classification



CONTROL VALVE FLOW CHARACTERISTICS

Trim design will affect how the valve capacity changes as the valve moves through its complete travel. Because of the variation in trim design, many valves are not linear in nature. THE RELATIONSHIP BETWEEN VALVE CAPACITY AND VALVE TRAVEL IS KNOWN AS THE FLOW CHARACTERISTIC OF THE VALVE. Valve trims are specially designed, or characterized, in order to meet the large variety of control application needs. This is necessary because most control loops have some inherent nonlinearities, which you can compensate for when selecting control valve trim.

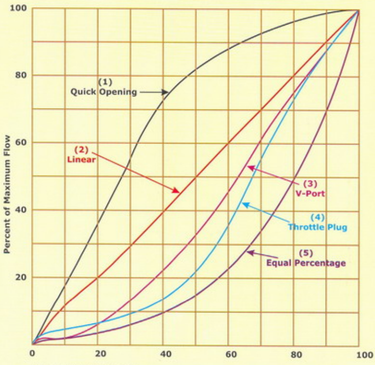
lift. It usually has too high a valve gain for use in Charts similar to Figure 1 (see below) are used to illustrate various control valve flow characteristics. The percent of full flow through the valve is plotted against valve stem position. The curves shown are typical of those available from valve manufacturers. These curves are typical of those available from valve manufacturers. These curves are based on CONSTANT PRESSURE DROP across the valve and are called INHERENT FLOW CHARACTERISTICS

The quick - opening characteristic provides large changes in flow for very small changes in

Modulating control. So it is limited to on - off service, such as sequential operation in either batch or semi-continuous processes.
The majority of control applications are valves with linear, equal - percentage, or modified - flow characteristics.

- Linear - flow capacity increases linearly with valve travel.
- Equal percentage - flow capacity increases exponentially with valve trim travel; equal increments of valve travel produce equal percentage changes in the existing Cv.
- A modified parabolic characteristic - is approximately midway between linear and equal - percentage characteristics. It provides fine throttling at low flow capacity and approximately linear characteristics at higher flow capacity.

When valves are installed with a pump, pipes, fittings, and other process equipment, the pressure drop across the valve will vary as the plug moves through its travel. When the actual flow in a system is plotted against valve opening, the curve is called the INSTALLED FLOW CHARACTERISTIC.



(1) Quick Opening = Quick Opening Plugs Characteristic
(2) Linear = Linear Plugs Characteristic
(3) V-Port = V-Port Plugs Characteristic
(4) Throttle Plug = Throttle Plugs Characteristic
(5) Equal % = V.POP Plugs. Micro form & Micro flute plugs Characteristic

Figure 1 - inherrent Flow Characteristics For Common Valve Trim Designs

CONTROL VALVE PACKING

Packing is a sealing system which normally consists of a deformable material such as TFE, graphite, asbestos, Kalrez, etc. Usually the material is in the form of solid or split rings contained in a packing box. Packing material is compressed to provide an effective pressure seal between the fluid in the valve body and the outside atmosphere.

At one time it was believed that the more packing you had in a control valve the better it would seal. Since FUGITIVE EMISSIONS has become a concern, extensive studies have been made which have shown that **better sealing can be obtained by minimizing the number of packing rings.**

New standards are being developed to which manufacturers will be asked to test their control valves. Test results from using these standards will allow a user to predict with some certainty how well a particular valve and packing combination will hold up.

DEFINITIONS

Consolidation: Packing consolidation is the shortening of a packing stack under load due to the elimination of voids in, between, and around the packing rings. This causes a reduction in packing stress (Radial Load) and consequently an increase in leakage. Consolidation can occur when the packing wears, cold flows, is subjected to thermal gradients, or if a non- uniform stress distribution in the packing exists.

Extrusion: When packing is loaded to its proper stress level in has a tendency to cold flow and will extrude between the stem and the follower. Any increase in temperature will increase the tendency of the packing to cold flow. PTFE is very susceptible to this because the hotter it is the quicker it will cold flow and because PTFE has and expansion rate roughly ten times that of carbon steel. As the packing tries to expand in the fixed volume of the packing gland, extrusion will occur. This material loss due to extrusion will relieve the axial stress, which relaxes the radial stress and results in a loss of seal.

Migration: Packing migration occurs when a portion of the packing is caught by a rough stem and is removed from the packing box as the stem slides in and out of the packing box. (Applies only to Linear Valves.)

PACKING SYSTEM DESIGN PRINCIPLES

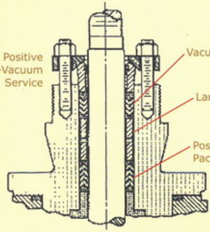
1. In order to minimize stem friction and wear on the packing, the stem surface finish should in the 8 to 16 RMS range.

2. The stem of the valve should be held concentric with the packing bore. This helps to uniformly compress the packing. This is best accomplished by guiding the stem at the top and the bottom of the packing bore.

3. To minimize packing extrusion under load, the inner diameter of packing spacers should be held as close to the stem diameter as possible. Anti-extrusion washers can also be helpful in minimizing extrusion.

4. It is desirable to use a wiping mechanism. The stem - wiping device

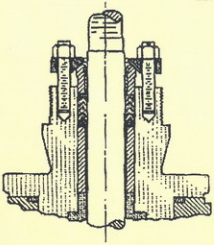
Dual Packing



The live - loading packing spring is replaced by a fixed spacer of the same material as the trim material.

Pressure inside the valve is alternately greater than of less than (i.e. Vacuum) ambient Pressure.

Jammed Packing



SEAT LEAKAGE CLASSIFICATIONS

Rule of Thumb:
There is no such thing as "Bubble Tight."

Control valves are designed to throttle. However, this is not a perfect world, and control valves are also usually expected to provide some type of shut - off capability. A control valve's ability to shut off has to do with many factors. The type of valves for instance. A double - seated control valve will usually have very poor shut - off capability. The guiding, seat material, actuator thrust, pressure drop, and the type of fluid can all play a part in how well a particular control valve shuts off.

There are actually six different seat leakage classifications as defined by ANSI/FCI 70-2-1976. But for the most part you will be concerned with just two of them: CLASS IV and CLASS IV is also known as METAL TO METAL. It is the king of leakage rate you can expect from a valve with a metal plug and metal seat. CLASS VI is know as a SOFT or seat or both are made from some king of composition material such as Teflon.

Valve LeaKage Classifications

Class I. Identical to Class II, III, and IV in construction and design intent, but no actual shop test is made.

Class II. Intended for double - port or balanced singe - port valves with a metal piston ring seal and metal - to - metal seats. Air or water at 45 to 60 psig is the test fluid. Allowable leakage is 0.5% of the rated full open capacity.

Class III. Intended for the same types of valves as in class II. Allowable leakage is limited to 0.1% of rated valve capacity.

Class IV. Intended for single - port and balanced single - port valves with extra - tight piston seals and metal - to - metal seats. Leakage rate is limited to 0.01% of rated valve capacity.

Class V. Intended for the same types of valves as Class IV. The test fluid is water at 100 psig or\ operating pressure. Leakage allowed is limited to 5 X 10 ml per inch of orifice diameter per psi differential.

Class VI. Intended for resilient - seating valves. The test fluid is air or nitrogen. Pressure is the lesser of 50 psig or operating pressure. The leakage limit depends on valve size and ranges from 0.15 to 6.75 ml per minute for valve sizes 1 through 8 inches.

Nominal Port Diameter (Inches)	Allowable Leakage (m1 per Minute)	(* Bubbles per Minute)
1	0.15	1
1.5	0.30	2
2	0.45	3
2.5	0.60	4
3	0.90	6
4	1.70	11
6	4.00	27
8	6.75	45
10	9.00	63
12	11.5	81

* Bubbles per minute as tabulated are a suggested alternative based on a suitable calibrated measuring device, in this case a 0.25 - inch O.D. X 0.032 - inch wall tube submerged in water to a depth of from 1/8 to 1/4 inch. The tube end shall be cut square and smooth with no chamfers or burrs. The tube axis shall be perpendicular to the surface of the water. Other measuring devices may be constructed and the number of bubbles per minute may differ from those shown as long as they correctly indicate the flow in milliliters per minute.

Note: Provisions should be made to avoid over pressuring of measuring devices resulting from inadvertent opening of the valve plug.

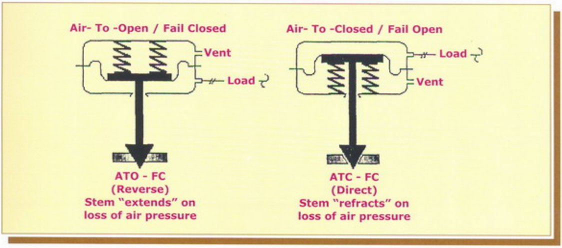
Taken from ANSI B16.104-1976.

CONTROL VALVE "FAIL - SAFE" POSITIONS

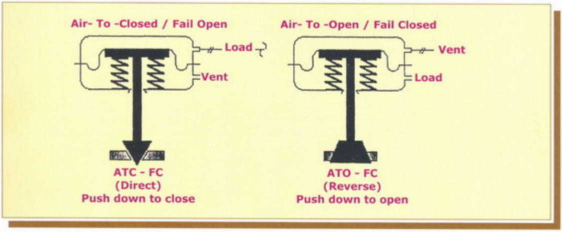
Cause of Fail - Safe Condition: Loss of Air Pressure.

A. LINEAR SPRING/DIAPHRAGM ACTUATORS. Used with sliding stem control valves: i.e. globe - style valves. Can be accomplished two ways:

1. Fixed seat ring/plug orientation. Springs are interchanged to either above or below actuator diaphragm.

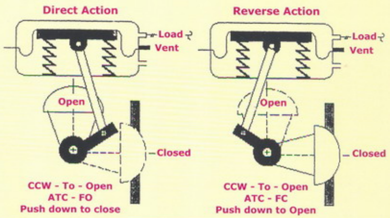


2. Fixed spring orientation. Plug and seat ring positions are reversed relative to each other. In the Fail\ Open design, plug travel is above the valve seat. in the fail closed design, plug travel is below the seat

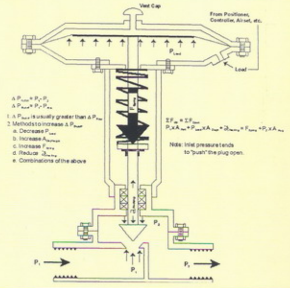


ROTARY SPRING / DIAPHRAGM ACTUATORS

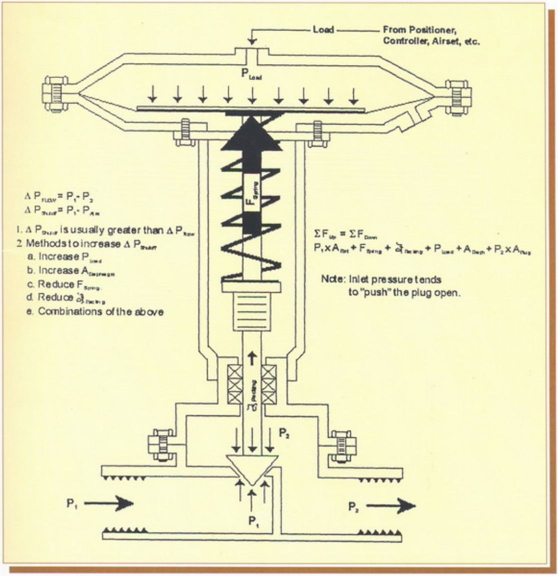
Used with rotary control valves; i.e. Butterfly, eccentric plug. Reversing the fail mode for this type of valve is normally accomplished by reversing the location of lever arm and plug. In order to maintain consistency, ATO - FC action will be considered as "Reverse" action for rotary or sliding - stem control valves.



CONTROL VALVE ATO - FC ACTION



CONTROL VALVE ATC - FC ACTION



VALVE POSITIONERS

A Valve Positioner is a device used to increase or decrease the air pressure operating the actuator unit the valve stem reaches the position called for by the instrument controller.

Positioners are generally mounted on the side or top of the actuator. They are connected mechanically to the valve stem so that stem position can be compared with the position dictated by the controller.

A positioner is a type of air relay which is used between the controller output and the valve diaphragm. The positioner acts to overcome hysteresis, packing box friction, and valve plug unbalance due to pressure drop. It assures exact positioning of the valve stem in accordance with the controller output.

REASONS TO USE POSITIONERS

- Increase control system resolution: i.e. fine control.
- Allow use of characteristic cams. Minimize packing friction effects: i.e. high - temperature packing.
- Negate flow - induced reactions to higher pressure drops.
- Increase speed of response to a change in process.
- Allow split ranging.
- Overcome seating friction in rotary valves. Allow distances between controller and control valve.
- Allow wide range of flow variation: i.e. operate at less than 10% travel under normal conditions.
- Allow increased usage of 4-20 mA electronic signal.
- Increase fast venting (unloading) capability. Permit use of piston actuators.
- Facilitate operation when the higher number in the bench - set range is greater than 15 psig: i.e. 10-30 psig, 6-30 psig, etc.

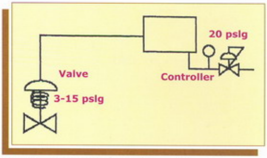
HOW POSITIONERS WORK

Although there are many different types of positioners, the basic principles of operation are similar for all of them.

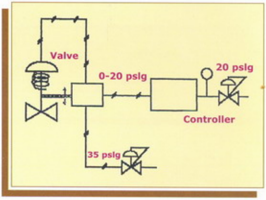
PRINCIPLE OF OPERATION

The positioner is mechanically connected to the stem of the valve. This steam position is compared with the position called for by the instrument.

controller, is by the instrument output air signal. A separate air supply is brought into the positioner for positioning the valve at exactly the point called for by the controller.



Single - Seated Control Valve without Positioner, Air - To Close



Single - Seated Control Valve with Positioner Air - To - Close

F1 - (Flow Recovery coefficient)

F1= The valve pressure recovery factor, a dimension less quantity. (Measured when valve is not choked.)

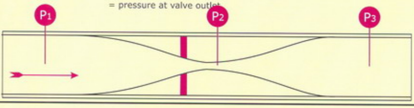
$$F1 = \sqrt{(P1-P2)/(P1-PVC)}$$

P_1= pressure at valve inlet
P_2= pressure at valve outlet

$\triangle P = P_1 - P_2$

P_n = pressure at Vena Contracta

= pressure at valve inlet
= pressure at valve outlet



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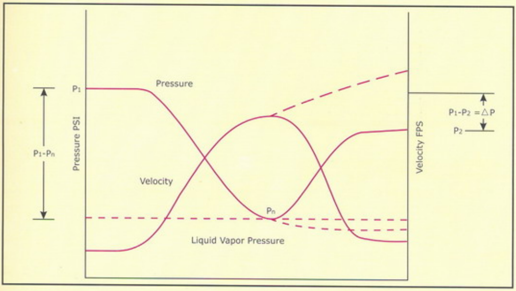
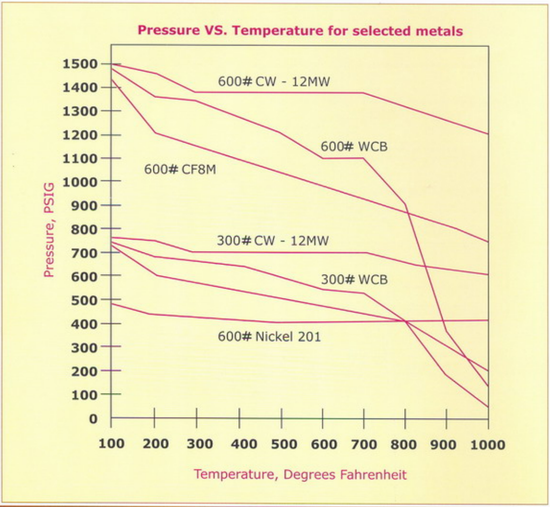
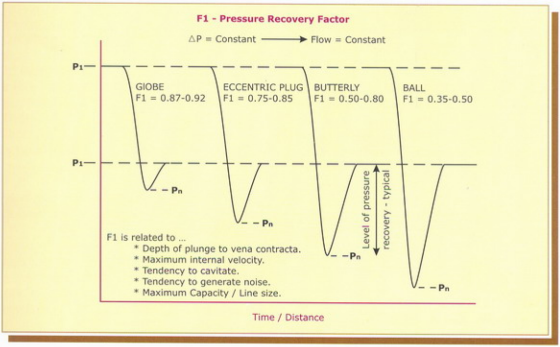




F1 - PRESSURE RECOVERY FACTOR

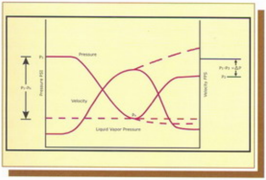
LOW - RECOVERY RATE: A valve desing that disspates a considerable amount of folw - stream energy due to turbulence created by the contours of the flow path. Consequently, pressure downstream of the valve vena contracta recovers to a lesser percentage of its inlet value than a valve with a more streamlined flow path. The F1 factor does not vary with travel to any significant degree.

HIGH - RECOVERY RATE: A valve design that disspiates relatively little flow - stream energy due to streamlined internal contours and minimal flow turbulence. Therefore, pressure down stream of the valve vena contracta recovers to a high percentage of its inlet value. The F1 factor of a high recovery valve will vary with its plug travel.



PRESSURE RECOVERY FACTOR(F1)

The graph below represents actual test data of a butterfly valve showing change in F1 with plug rotation.
The data demonstrate why a rotary control valve can suddenly go into cavitation as the valve opens up.



CASHCO TERMINOLOGY

ACTUATOR: A fluid - powered or electrically powered device that supplies force and motion to a VALVE CLOSURE MEMBER.

AIR SET: Also SUPPLY PRESSURE REGULATOR. Adevice used to reduce plant air supply to valve POSITIONERS and other control equipment. Common reduced air supply pressures are 20 and 35 psig.

AIR - TO - CLOSE: An increase in air pressure to the ACTUATOR is required to cause the valve to close. This is another way of saying the valve is open or Normally Open.

AIR - TO - OPEN: An increase in air pressure to the ACTUATOR is required to cause the valve to open. This is another way of saying the valve is FAIL CLOSED or NORMALLY CLOSED.

CASHCO TERMINOLOGY

ANSI: An abbreviation for the American National Standards Institute.

ANTI - CAVITATION TRIM: A special trim used in CONTROL VALVES to stage the pressure drop through the valve, witch will either prevent the CAVITATION from occurring or direct the bubbles that are formed to the center of the flow stream away from the valve BODY and TRIM. This is usually accomplished by causing the fluid to travel along a torturons path or through successively smaller orifices or a combination of both.

API: An abbreviation for the American Petroleum Institute.

ASME: An abbreviation for the American society of Mechanical Engineers.

ASTM: An abbreviation for the American Society for Testing and Materials.

BALANCED TRIM: A trim arrangement that tends to equalize the pressure above and below the valve plug to minimize the net static and dynamic fluid flow forces acting along the axis of the stem of a GLOBE VALVE. Some regulators also use this design, particularly in high pressure service.

BELLOWS SEAL BONNET: A BONNET which uses a BELLOWS for sealing against leakage around the valve plug stem.

BENCH SET: The proper definition for bench set is the INHERENT DIAPHRAGM PRESSURE RANGE which is the high and low valves of pressure applied to the diaphragm to produce rated valve plug travel with\ atmospheric pressure in the valve body. This test is often performed on a work bench in the instrument shop pror to placing the valve into service and is thus known as Bench set.

DIRECT ACTING: This term has several different meanings depending upon the device it is describing. A DIRECT - ACTING ACTUATOR is one in which the actutor stem extends with an increase in diaphragm pressure. A DIRECT - ACTING VALVE is one with a PUSH - DOWN - TO - CLOOSE plug and seat orientation. A DIRECT - ACTING POSITIONER or a DIRECT - ACTING CONTROLLER outputs an increase in signal in response to an increase in set point.

DIRECT ACTUATOR: Is one in which the actuator stem extends with an increase in diaphragm pressure.

DUAL SEATING: A valve is said to have dual seating when it uses a resilient or composition material such as TFE, Kel - F, or Buna - N, etc. For its primary seal and a metal - to - metal seat as a secondary seal. The idea is that the primary seal will provide tight shut - off Class VI and if it is damaged the secondary seal will backup the primary seal with Class VI, shut - off.

DYNAMIC UNBALANCE: The total force produced on the valve pulg in any stated open position by the fluid pressure acting upon it. The particular style of valve, i.e. single - ported, double - ported, flow - to - open, flow - to - close, has an effect on the amount of dynamic unbalance.

EFFECTIVE AREA: For a DIAPHRAGM ACTUATOR, the effective area is that part of the diaphragm area that is effective in producing a stem force. Usually the effective area will change as the valve is stroked - being at a maximum at the start and at a minimum at the end of the travel range. Flat sheet diaphragms are most affected by this; while molded diaphragms will improve the actuator performance, and a rolling diaphragm will provide a constant stem force throughout the entire stroke of the valve.

ELECTRIC ACTUATOR: Also known as an Electro - Mechanical Actuator uses an electrically operated motor - driven gear train or screw to position the actuator stem. The actuator may respond to either a digital or analog electrical signal.

END CONNECTION: The configuration provided to make a pressure - tight joint to the pipe carrying the fluid to be controlled. The most common of these connection are threaded, flanged, or welded.

EQUAL PERCENTAGE: A term used to describe a type of valve flow characteristic where for equal increments of valve plug travel the change in flow rate with respect to travel may be expressed as a constant percent of the flow rate at the time of the change. The change in flow rate observed with respect to travel will be relatively small when the valve plug is near its seat and relatively high when the valve plug is nearly wide open.

EXTENSION BONNET: A bonnet with a packing box that is extended above the body to bonnet connection so as to maintain the temperature of the packing above (cryogenic service) or below (high - temp service) the temperature of the process fluid. The length of the extension depends on the amount of temperature differential that exists between the process fluid and the packing of

FACE - TO - FACE: Is the distance between the face of the inlet opening and the face of the outlet opening of a valve or fitting. These dimensions are governed by ANSI/ISA specifications. The following uniform Face - to Face Dimensions apply.

SPECIFICATION VALVE TYPE ANSI/ISA S75.03 INTEGRAL FLANGED GLOBE STYLE CONTROL VALVES ANSI/ISA S75.04 FLANGELESS CONTROL VALVES ANSUISA S75.20 SEPARABLE FLANGE GLOBE STYLE CONTROL VALVES.

FAIL - CLOSED: Or NORMALLY CLOSED. Another way of describing an AIR - TO - OPEN actuator. Approximately 80% of all spring return diaphragm operators in the field are of this construction.

FAIL - IN - PLACE: A term used to describe the ability of an actuator to stay at the same percent of travel it was in when it lost its air supply. On SPRING RETURN ACTUATORS this is accomplished by means of a LOCK - UP VALVE. On PISTON ACTUATORS a series of compressed air cylinders must be employed.

FAIL - SAFE: A term used to describe the desired failure position of a control valve. It could FAIL - CLOSED, FAIL - OPEN, or FAIL - IN - PLACE. For a spring - return operator to fail - in - place usually requires the use of a lock - up valve.

FEEDBACK SIGNAL: The return signal that results from a measurement of the directly controlled variable. An example would be where a control valve is equipped with a positioner. The return signal is usually a mechanical indication of valve plug stem position which is fed back into the positioner.

F1: Or PRESSURE RECOVERY FACTOR. A number used to describe the ratio between the pressure recovery after the VENA CONTRACTA and the pressure drop at the vena contracta. It is a measure of the amount of pressure recovered between the vena contracta and the valve outlet. Some manufacturers use the therm Km to describe the pressure recovery factor. This number will be high (0.9) for a GLOBE STYLE VALVE with a torturous follow path and lower (0.8 to 0.6) for a ROTARY STYLE VALVE with a streamlined flow path. On most rotary products the F1 factor will vary with the degree of opening of the VALVE CLOSURE MEMBER. Note! F1 does not equal