

LIQUID COOLING SYSTEM COMPONENTS

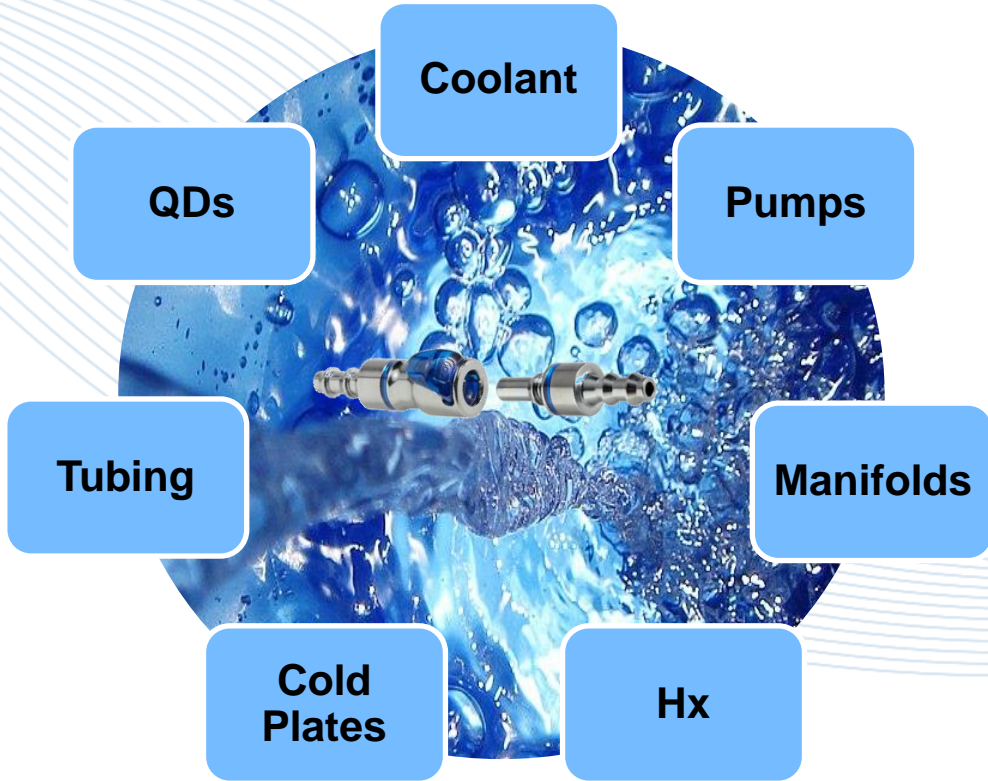
GUIDELINES FOR THE SPECIFICATION PROCESS

Beth Langer

A large blue square graphic with a white grid pattern that curves and warps, creating a sense of depth and movement. The word "AGENDA" is written in large, white, bold, sans-serif capital letters across the center of the graphic.

AGENDA

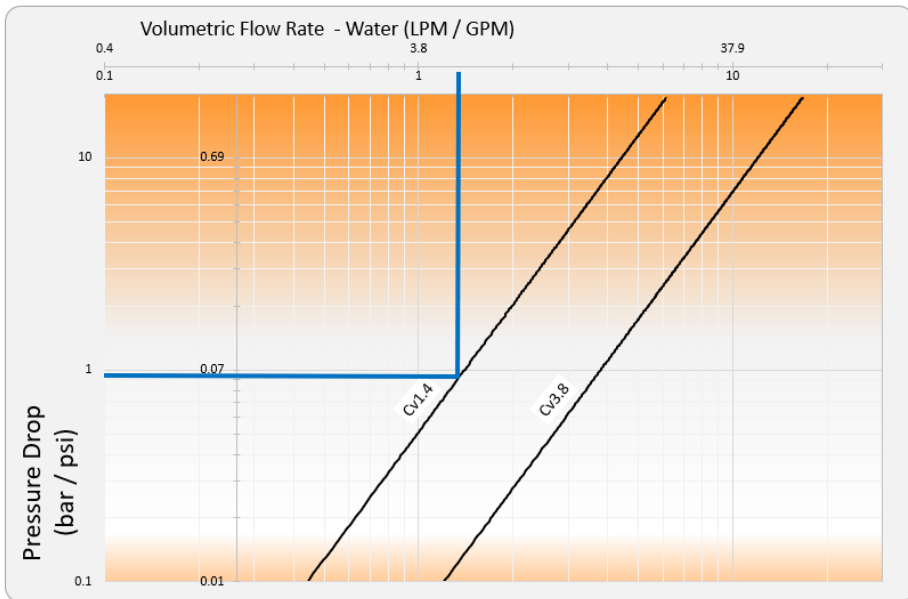
- **Component Ecosystem**
- **Flow**
- **Materials**
- **Compatibility**
- **Specification Criteria**



In a wetted environment
every component and
subcomponent matters



Coolant links all wetted system components



Flow coefficient – C_v

- Volumetric flow rate for 1psi loss

Balance flow and pressure for optimal performance and efficiency

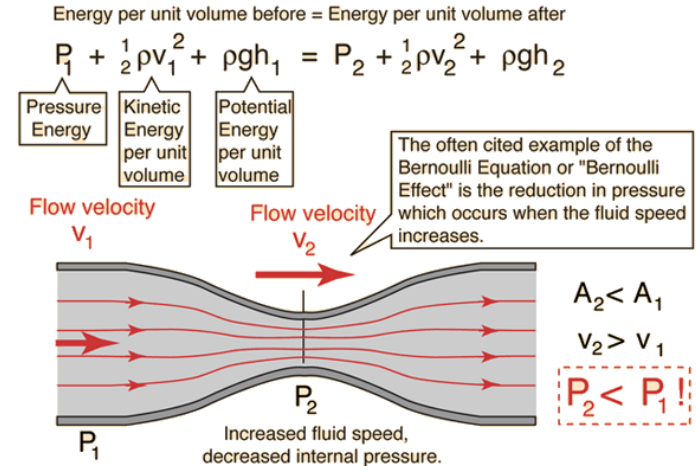
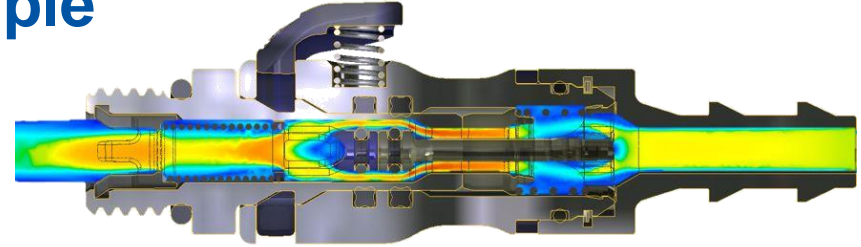
$$Q = C_v \sqrt{\frac{\Delta P}{SG}}$$



*Published and catalog C_v is typically reported with water ($SG = 1$)
Use correction factors and correct SG when using coolants other than water*

Flow sizing – QD as example

- Achieve increased cooling efficiency with properly spec'd devices throughout the system
- Sizing a QD for optimal performance – reduce pressure loss, consider physical size



- Structural
- Wetted

Metals

Engineered
Plastics

Elastomers

PERFORMANCE CHARACTERISTICS

Commodity
Plastics

Engineered
Plastics

Metal
Alloys

High
Performance
Metal

- PPSU
- PEEK

- Brass, Aluminum, Copper

- Stainless

Low

PRICE

High

Lighter

WEIGHT

Heavier

Resistant

CORROSION

Susceptible

Metals

Anticipate galvanic potential of dissimilar metals

Considerations

- High and low temp applications
- Alloying elements
- Cost and weight

Failure modes

- Corrosion
- Erosion
- Wear and fatigue



Elastomers

Specific application testing: replicate operating conditions, temp, pressure, fluid, etc.

Considerations

- High and low temp applications
- Fluid loss
- Hardness
- Thermal resistance
 - Continuous and intermittent
 - Brittleness and TR10 temp
- Compounding – fillers, plasticizers, etc.

Failure modes

- Time/temperature dependent
- Physical and chemical degradation
- Comp set and stress relaxation
- Volume swell
- Shrinkage from extractables
- Thermal expansion/contraction
- Extrusion damage

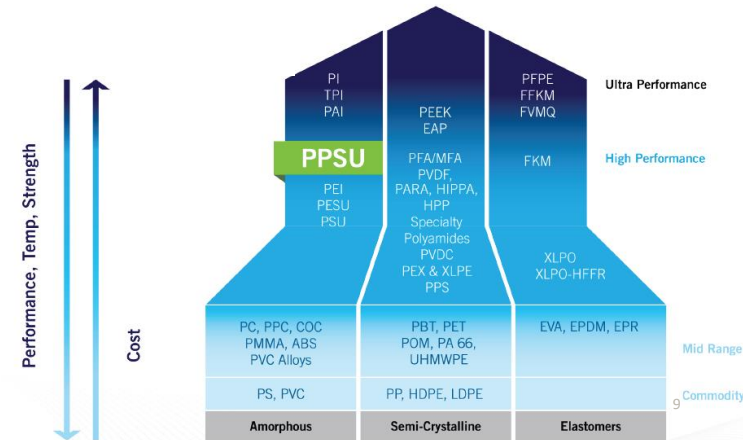
Thermoplastics

Considerations

- Flammability
- Thermal resistance and stability
- Continuous and intermittent
- Creep, RTI
- Compounding – fillers, plasticizers, etc
- Chemical compatibility

Failure modes

- Chemical attack
- Crazeing, cracking, discoloration
- Fluid absorption/swelling
- Thermal degradation, creep
- Internal pressure stress
- Extractables



Chemical compatibility, corrosion, erosion

- Coolant compatibility
 - Elastomeric seals
- Galvanic corrosion
- Flow path erosion
- Environmental exposures



*Consider all materials
within wetted fluid loop,
and interactions they
may have*

Fluids can affect elastomers in two ways: physical interaction, such as swelling, and chemical interaction. The first is generally reversible, while the other is not.

Parameter	Metrics
Flow Rate	L/min, gpm
Flow Coefficient	Kv, Cv
Operating Pressure	Pa, psi
Burst Pressure	Pa, psi
Pressure drop	Pa
Spillage (liquid expunction)	mL, cc
Inclusion (air introduction)	mL, cc
Temperature – Operating, Storage / Shipping	°C, °F
Connection Force	N, lbf
Connection Cycles	Mechanical cycles / connect and disconnect
QD style and hydraulic diameter	Inches (eg. Blind mate, hand mate, threaded, mounting configuration)
Terminations	Barbed, compression style, threaded



- Design
- Request
- Test

What questions do you have?

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