Aerosol Valves

Aerosol 101

Tim Yerby
Corporate Technical Director
Precision Valve Corporation
THE AEROSOL VALVE
BENEFITS OF AEROSOLS

- Convenient
- Easy to Use/Immediate Use
- Controlled Application
- Compact
- Portable
- Long Lasting
- Particle size/pattern control
- Continuous spray
- Recyclable (Regional)
VALVE FUNCTION

- RELEASE THE CONTENTS
- PERMIT FILLING OF PROPELLANT
- ACT AS AN HERMETIC SEAL
HISTORY

- 1790 France: Self-Pressurized carbonated beverage introduced
HISTORY

- 1927 Norway: Erik Rotheim develops the first aerosol can & valve that holds and dispenses propellant & product.
1943 USA: Department Of Agriculture researchers Goodhue & Sullivan develop a small aerosol can pressurized by a liquefied gas. Service men spray malaria infested mosquitoes.
Post War Commercialization: Valve staked into a “Beer Can”

1949: Bob Abplanalp develops the first one inch aerosol valve. Aerosols become inexpensive and practical
HISTORY

[Image of various containers with the years 1942, 1944, 1946, 1947, and 1949]
1953: Robert H Ablanalp patents the aerosol valve as we know it today
HISTORY
VALVE COMPONENTS

*7 COMPONENTS*

- **ACTUATOR**--CONTROLS PATTERN AND FLOW
- **STEM**--CONTROLS FLOW
- **STEM GASKET**--THE “ON/OFF” SWITCH
- **SPRING**--CLOSES THE VALVE
- **HOUSING (BODY)**--ENCLOSES SPRING/STEM. ALSO CONTROLS FLOW
- **DIP TUBE**--DRAWS PRODUCT UP INTO THE VALVE
- **MOUNTING CUP (WITH MOUNTING CUP GASKET)**--THE LINK BETWEEN CAN AND VALVE
ASSEMBLED VALVE

- Stem
- Stem Gasket
- Spring
- Mounting Cup
- Housing
- Dip Tube
Pressure on the actuator depresses the stem. This movement interrupts the sealing action of the gasket and exposes the stem orifice to the pressurized flow of the product in the container, thereby opening the valve. When the actuator is released, the spring returns the stem orifice to the sealed position, closing the valve.
OPERATION

**Product Flow Through The Valve**

1. Dip Tube
2. Housing
3. Stem
4. Actuator
OPERATION

Headspace

Product
PROPELLANTS

- PROPELLANTS GENERATE PRESSURE INSIDE THE CAN
- WIDE RANGE OF PRESSURES (17 PSIG--140 PSIG)

Pressure Gauge
PROPELLANTS

- LIQUEFIED UNDER PRESSURE
- COMPRESSED GAS
PROPELLANTS
PROPELLANTS

HYDROCARBONS
- A-17 (BUTANE)
- A-31 (ISOBUTANE)
- A-108 (PROPANE)
- Blends (A-46, A-70, etc)
- Liquid Under Pressure
- Integral to the Formulation
PROPELLANTS

- DME (Dimethyl Ether)
- 152a (1, 1-Difluoroethane)
- 134a (1, 1, 1, 2-Tetrafluoroethane)
PROPELLANTS

COMPRESSED GASSES

- CO₂
- N₂
- N₂O
- Pressure Drops as Unit Empties
- A Wet Spray
# PROPELLANTS

<table>
<thead>
<tr>
<th>Liquefied</th>
<th>Compressed</th>
</tr>
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<tbody>
<tr>
<td>An integral part of the formula. Results in smaller, finer particles.</td>
<td>Acts like a piston. Large, wet particles. (However, there is some solubility with CO2)</td>
</tr>
<tr>
<td>Consistent pressure through life of can</td>
<td>Drop in pressure through life of can</td>
</tr>
<tr>
<td></td>
<td>Caution with CO2 + H2O! Carbonic acid formation.</td>
</tr>
<tr>
<td></td>
<td>Temperature changes have little effect on pressure. (Good for de-icers, e.g.)</td>
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<tr>
<td>Large temperature changes effect pressure.</td>
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<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost varies</td>
<td>Low cost</td>
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VALVE COMPONENTS

Functions & Materials of Construction
STEMS

CONTROL THE FLOW

ORIFICE SIZES: 0.010” TO 4 X 0.027 X 0.045”
INJECTION MOLDING

Injection Molding Machines

Two halves of a mold

Cavity

Runner
STEMS

STEM HEIGHT RELATIONSHIPS

STEM HEIGHT

STEM EXTENSION

PEDESTAL HEIGHT

STEM HEIGHT MINUS STEM EXTENSION = PEDESTAL HEIGHT
STEMS

Stem height too high causing lifting of the finger pad
STEM GASKETS

- COVERS THE STEM ORIFICE (The on-off switch)
- DIFFERENT MATERIALS AVAILABLE FOR PRODUCT COMPATABILITY
  - BUNA N
  - NEOPRENE
  - BUTYL
  - VITON
STEM GASKETS

- *Remember:* The stem gasket seals the valve.
- *Remember:* It is made of rubber and will shrink or swell with different formulations.
- *Remember:* There is no universal stem gasket.
- Testing is recommended (more later on)
SPRINGS

- CAUSES THE VALVE TO CLOSE
- STAINLESS STEEL (302, 316)
HOUSING (BODY)

- ENCLOSES THE SPRING AND STEM
- ACTS AS A SECONDARY METERING ORIFICE
- WIDE RANGE OF ORIFICE SIZES 0.013” TO 0.158”
HOUSING

Standard

Capillary

Jumbo

“Inverted”
HOUSING (BODY)

- VAPOR TAP (A HOLE IN THE SIDE OR BOTTOM OF THE HOUSING)
  -- 0.005” TO 0.040”
  -- PRODUCES A DRIER AND WARMER SPRAY
  -- REDUCES PARTICLE SIZE
  -- NEEDS SUFFICIENT PROPELLANT TO EVACUATE
  -- DO NOT USE WITH COMPRESSED GAS
DIP TUBES

- DRAW PRODUCT UP INTO THE VALVE
- STANDARD: 1/8” (0.122”) INSIDE DIAMETER
- LARGE: 3/16” (0.190”) INSIDE DIAMETER
- JUMBO: OVER 1/4” (0.260”) INSIDE DIAMETER
- CAPILLARY: < 0.060” INSIDE DIAMETER
DIP TUBES

- NOTCHED TO PREVENT CLOSING OFF AT BOTTOM OF CAN
- LENGTH MEASURED FROM TOP OF CUP TO END OF TUBE (“CSPA” LENGTH)
- CSPA RULERS AVAILABLE
DIP TUBES

- Can use the dip tube curvature to your advantage
- Orient the dip tube for your particular application
- Will ensure complete evacuation
DIP TUBES

- 0 degree orientation for downward spray (starch, furniture polish, etc)

Mark on cup

Dip tube is here
DIP TUBES

180 Degree orientation for upward spray (Room fresheners, space sprays, etc.)

Mark on cup

Dip tube is here
MOUNTING CUPS

- HOLD VALVE PARTS TOGETHER
- ATTACHES VALVE TO CAN
- TINPLATE OR ALUMINUM
- EPON COATED OR UNCOATED
MOUNTING CUPS

- GASKET MATERIALS
- PROVIDES A SEAL BETWEEN CUP AND CAN
- POLYETHYLENE SLEEVE FULLY BONDED TO MOUNTING CUP
- PP LAMINATE (ACTS AS COATING AND SEAL)
- CUT GASKET (AKA LATHE CUT GASKET) BUNA, NEOPRENE OR BUTYL
MOUNTING CUPS

Polyethylene Sleeve

Polypropylene Laminate

Lathe Cut Gasket
Which mounting cup gasket do I need?

- SLEEVE and LAMINATE
- Sleeve and laminate for general purpose tinplate cans
- Sleeve and laminate for non-milled aluminum cans less than 50mm in diameter
MOUNTING CUPS

✓ CUT GASKET

✓ Cut gasket for *any* size milled (machined) aluminum can

✓ Cut gasket for any aluminum cans 50mm and greater in diameter

✓ Cut gasket can be used with any can and valve combination...but $$$$$$$$$$
CRIMP CONSIDERATIONS

• Crimp: The method by which the valve is attached to the can
• Collets move into the mounting cup and spread to a specific diameter and depth
CRIMP CONSIDERATIONS

Closed Collet

Open Collet
CRIMP CONSIDERATIONS

Closed collet

Open collet in cup
Crimp Considerations

- Crimp dimensions will depend on:
  - Mounting cup material
  - Mounting cup gasket
  - Type of can
- Valve suppliers can give *starting point* dimensions
CRIMP CONSIDERATIONS

Gauges and setting block are a must!!!
ACTUATORS
ACTUATORS
ACTUATORS
ACTUATORS “Non-MBU”

• NON-MECHANICAL BREAKUP
• A DIRECT FLOW THROUGH THE ACTUATOR
• USUALLY RESULTS IN A STREAM
ACTUATORS “MBU”

- MECHANICAL BREAK UP
- INCORPORATES A SWIRL CHAMBER
- RESULTS IN A DISCERNABLE PATTERN SIZE AND SHAPE

Swirl Chamber
ACTUATORS “MBU”

“Shell” Assembled Actuator

Insert with 4 tangential entry channels
ACTUATORS “MBU”

 Detail of a mechanical break up insert
VALVE TYPES

- **VERTICAL VALVE**—VERTICAL PRESSURE ON THE ACTUATOR OPENS THE VALVE.
VALVE TYPES

- **TILT VALVE**--FORWARD PRESSURE ON THE ACTUATOR OPENS THE VALVE.
VALVE TYPES

- **UP/DOWN VALVE**--INCORPORATES A SPECIAL HOUSING FOR UPRIGHT OR INVERTED USE
VALVE TYPES

*20mm VALVE*
VALVE TYPES

- MALE VALVE
- FEMALE VALVE
VALVE TYPES

• METERING VALVE

GASKET
BARRIER/BAG-IN-CAN SYSTEMS

- BAG IN CAN/BAG On VALVE
- PISTON
How are aerosols filled in production?

- Cans are “depalletized” and placed on line
- Liquid is filled into the cans
- Valves are inserted into cans
- Propellant is added by
- One of three methods:
FILLING METHODS

- UTC (UNDER-THE-CUP)
- PRESSURE FILLING
- GASSER SHAKER
FILLING METHODS

- UTC (Under the cap/cup) Operation
- Pulls a vacuum
- Injects propellant into the can
- Crimps valve to the can
- Used by over 50%
FILLING METHODS

UTC (UNDER THE CUP)

Propellant

Single Head Under Capper
FILLING METHODS

- Pressure Filling
- Can is vacuumed and valve crimped to can
- Propellant fills through and around the valve
- Can be filled actuator on or off (Limited by actuator size)
FILLING METHODS

- PRESSURE FILL

Pressure Fill Button Off
Single Head Pressure Filler
FILLING METHODS

- Gasser Shaker
  - Can is vacuumed and valve crimped to can
  - Literally “shakes” the propellant into the can
  - Not common
  - Used mostly for compressed gas propellants (CO2)
FILLING METHODS

- GASSER SHAKER
FILLING METHODS

- After propellant is added cans are run through a hot water bath
- Internal can pressure must be equal to what the pressure would be at 130 degrees Fahrenheit
- May need to adjust water bath temp and dwell time to accomplish above
VALVE SELECTION

- CONSIDER EVERYTHING!!
- TEST PROGRAM
VALVE SELECTION

How Many Valve Combinations Are There?
Over 15,000 valve combinations (conservative estimate) not including gaskets and mounting cups
VALVE SELECTION

Where Do I Begin?

• Gather as much information as possible
  • Type of Propellant
  • Product/Propellant Ratio
  • Production Filling Method
  • Can Size/Material
Define The Parameters

• DRT, Pattern, Particle Size, Flammability
• Which Are Important For Your Product?
• Prioritize
VALVE SELECTION

SOME CONSIDERATIONS

- DELIVERY CHARACTERISTICS
- DELIVERY RATE
- SPRAY PATTERN
- PARTICLE SIZE
- FLAMMABILITY
- WEIGHT LOSS
- CORROSION
- CLOGGING
- OFF ODOR
- APPEARANCE
- LEAKAGE
- LABEL WEIGHT DELIVERY (EVACUATION)
VALVE SELECTION

- Get Valve Samples (free)
  - Valve suppliers can offer starting points for various products
- Determine correct stem gasket
STEM GASKETS

_importance

◆ By choosing the appropriate stem gasket you will avoid:

◆ **High weight loss** (loss of propellant and/or product) which can result in:
  - Wet cartons in the warehouse
  - Consumer Returns (will consumer buy this again?)
  - Litigation?
STEM GASKETS

How do I select the correct gasket for my product?

- Immersion Test
  - OK for initial screening

- Test in Packed Units
  - More realistic condition. It includes the propellant
STEM GASKETS

يزImmersion Test

• Gaskets in concentrate only, stored at room temperature.

يزIn Packed Units

• Test at room temperature and elevated temperature (120 f)
STEM GASKETS

※For either test you want to:
- Measure the **Outer Diameter** of the gasket
- Measure the **Thickness** of the gasket
- Measure the **Durometer** (Hardness) of the gasket if possible. Requires special equipment
STEM GASKETS

- Record measurements at:
  - 2 weeks
  - 1 month
  - 2 months

- Calculate % swell or shrinkage
STEM GASKETS

Interpretation of Results

- Valve gaskets can tolerate up to ~10% swell (check with the individual valve suppliers)

- AVOID SHRINKAGE AT ALL COSTS!!
  - Shrinkage compromises the seal

- Red Flag if there is a big change in durometer
VALVE SELECTION

- Initiate Stability (weight loss) testing
  - Spray Weigh or Dead Storage
  - Test for 30 days to 6 months at Room Temp and Oven (120 F)
  - At end of test check valve parts
  - Check for valve, container corrosion
VALVE SELECTION

* Speak with your filler (What are their requirements/limitations?)
  * How Filled? (Pressure Fill? UTC?)
  * Button-on (Special Adapters Needed?)
  * Button-off (Special Tippers Required?)
  * Hand Tipped (Are Actuators hard to tip?)
  * Covercaps/Shrink wrap (Any Problems?)
VALVE SELECTION

*Keep an eye out for:

- Swelling, cracking of the plastic parts (actuators, stem, housing, dip tubing)
- Coating integrity, pin holing, oxidation, corrosion of metal parts (mounting cups, springs)
- Impingement using spray thru caps and accessories
- Clogging with high solid products
VALVE SELECTION

- Don’t assume lab samples will equal production units
- Perform a test run on the production line
  - Reveal equipment issues
  - Reveals bulk handling issues
  - Will show line speed
  - Includes process variations
- Evaluate production filled units
TROUBLESHOOT

UNIT DOES NOT OPERATE AS EXPECTED

NO PROPELLANT AND/OR NO PRODUCT

NOT FILLED LEAKAGE

THRU CAN THRU VALVE

PINHOLE CORROSION DEFECTIVE CAN MTG CUP CORROSION GASKET DETERIORATION VALVE IS OPEN INCORRECT DIMENSIONS

FOREIGN PARTICLES DISRUPTING SEAL VALVE DEFECT DAMAGE DURING FILLING NO GASKET COMPRESSION (CUT GASKET)

WRONG CUP GASKET FOR CAN DEFECTIVE OR DAMAGED CAN

THRU CRIMP

FOREIGN PARTICLES CLOGGING VALVE NOT REALLY CLOGGED BUT A VALVE DEFECT

GASKET SWELL

IS ACTUATOR CLOGGED? IS VALVE CLOGGED?

CLOGGED/OR PARTIAL SPRAY BUT UNIT HAS PRESSURE

UNIT DOES NOT OPERATE AS EXPECTED

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GASKET SWELL

IS ACTUATOR CLOGGED? IS VALVE CLOGGED?
CALL US

❖ For Samples:
   ⭐ Clayton Boddie  914-966-4466

❖ For Technical Assistance:
   ⭐ Gioconda LLopis  914-966-4462
   ⭐ Serena Zondorak  914-966-4473
   ⭐ Mike Zerbe  914-966-4457
THANK YOU

ANY QUESTIONS?