POSITIVE DISPLACEMENT PUMPS

Tim Berschauer – Charles P. Crowley Company
VARIOUS TYPES of P.D. PUMPS:

1. **Diaphragm**
   - Mechanically Actuated Metering
   - Hydraulically Actuated Metering
   - Solenoid Driven Metering
   - Air Operated Diaphragm (A.O.D.)

2. **Peristaltic (Hose/Tube)**

3. **Progressive Cavity**

4. **Gear**
   - External Spur Gear
   - Internal Gear
   - Magnetically coupled

5. **Rotary Lobe**

6. **Sliding Vane**
WHAT IS A DIAPHRAGM METERING PUMP?

• Positive displacement, not dynamic.
  – Known amount of fluid is displaced per stroke.
  – Flow is independent of backpressure.
  – Stand alone metering capability.
• Reciprocating flow – not continuous flow.
• Precise (metered) displacement of fluid (typically GPH or LPH, not GPM or LPM).
• Uses stroking piston to actuate a diaphragm (either by mechanical or hydraulic means), which in turns displaces fluid.
• Flow is dependent upon:
  – Strokes/minute (SPM).
  – Stroke position (how far the piston is allowed to move back and forth).
WET END DIAPHRAGM ACTUATION

MECHANICALLY ACTUATED DIAPHRAGM

HYDRAULICALLY ACTUATED DIAPHRAGM
HYDRAULICALLY ACTUATED DIAPHRAGM

- Hydraulic balancing - no diaphragm point stresses.
- Diaphragm acts as “separator” and does no work.
- High pressure capability (3500 psi+).
- Long term life.
- Accuracy of up to +/- 1/2%.
- Solid TFE diaphragm as standard.
- Metallic diaphragm offerings available.
- High and low flow rates possible (0.13 GPH – 3500 GPH).
MECHANICALLY ACTUATED DIAPHRAGM

• Diaphragm mechanically attached to piston.
• Low pressure applications (<350 psig).
• Low to medium capacity (up to 200 GPH).
• Accuracy of +/- 2%.
• Lower initial cost.
• No hydraulic fluid, simpler to maintain.
• Limited low flow capability.
• Lower life expectancy.
• TFE faced elastomeric diaphragm.
SOLENOID ACTUATED DIAPHRAGM

- Diaphragm mechanically attached to piston.
- Low pressure applications (<350 psig).
- Accuracy of +/- 2%.
- Very low flow capability (3 GPD – 25 GPH (high end)).
- No motor – solenoid driven diaphragm.
- TFE faced elastomeric diaphragm.
- Compact footprint.
- Limited options – “pump in a box”.
- Low cost.
FLAT DIAPHRAGM

- Appropriate for most clean, thin to moderately viscous fluid pumping applications.
- Many different wet-end materials of construction available.
- Far and away the most popular diaphragm design.
- Available in both mechanically actuated and hydraulically actuated versions.
- Diaphragm leak detection adaptable.
- Three valve system keeps hydraulics stable.
TUBULAR DIAPHRAGM

• Appropriate for clean fluids or slurries with water like to highly viscous properties.
• Inherent double diaphragm pump.
• Leak detection adaptable.
• Available only in hydraulically actuated diaphragm style.
CONE DIAPHRAGM

- Appropriate for clean fluids or slurries with water like to highly viscous properties.
- Superior suction lift capabilities.
- Available in only hydraulically actuated diaphragm style.
Eliminates gas buildup that normally causes metering pumps to Vapor Lock
AIR OPERATED DOUBLE DIAPHRAGM
PERISTALTIC TUBE PUMPS

- 60 psi (4 bar) max
- Change Tube every 30-60 days for Safety
- Primary Advantage is Ease of Maintenance
Precision Metering in Low Pressure Applications

- Non-Reciprocating Design is Ideal for Gaseous Chemicals
- Limited Tube Life and Pressure Capacity
PROGRESSING CAVITY PUMPS

- Interference Fit Rotor/Stator Combination
- Mechanical Seal and limited magnetically coupled designs
- Lubricated by Process Fluid
- Excellent for High Viscosity and High Solids Content Fluids
- Polymers, High Pressure RAS/WAS, Sludge Transfer
Progressing Cavity Fluid Transmission

- A “Cavity” is formed between the metallic “Rotor” and the elastomeric “Stator”
- The rotation of the rotor element causes the “Cavity” to index forward
- Fluids are extruded through the pump
EXTERNAL GEAR PUMPS

- Constant, Pulseless Flow
- Lubricated by Process Fluid
- Ideal for Chemical Transfer and Select Feeding Applications
GEAR PUMP CONSTRUCTION

Gear Materials:
- Alloy C
- Alloy 20
- Teflon
- PEEK
- Carbon
- Special on request
GEAR PUMP CONSTRUCTION

- Wear Plates:
  - Protect the housing against wear from the gears

- Materials:
  - Carbon
  - Teflon
  - PEEK
  - Ceramic
  - Silicon Carbide
GEAR PUMP CONSTRUCTION

- **Bearings**
  - Support the drive and idler shafts

- **Materials:**
  - Carbon
  - Teflon
  - PEEK
  - Silicon Carbide
GEAR PUMP CONSTRUCTION

Shaft Seal

- Prevents leakage of fluid along drive shaft

Seal Types:

- John Crane Type 9
- John Crane Type 21
- Teflon Packing
- Graphoil Packing
- Magnetic Coupling (Hermetically Sealed)
MAGNETICALLY COUPLED GEAR PUMP

Fully non-metallic design with no shaft penetrations or mechanical seals
### FLUID PROPERTIES AND PUMP PERFORMANCE

What Affects Pump Performance?

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Legend:
- V = Viscosity
- vp = Vapor Pressure
- G = Specific Gravity
- S = Solids Content
- T = Temperature
GEAR PUMP PERFORMANCE

▲ Slip Paths

NORMAL FLOW □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ ^{
Internal Gear Pump

- Gears nest together internally
- Suction/Discharge oriented at 90 degrees
- Lower shear than External Gear pumps.
G/GA/GC4 GEARCHEM PUMP
1/2" PORTS

FLUID VISCOSITY 1 CPS
G/GA/GC4 GEARCHEM PUMP
1/2" PORTS
FLUID VISCOSITY 100 CPS

m³/h

U.S. GPM

BRAKE HORSEPOWER

PSIG

kPa