

# The Elimination of VOC Emissions from a Reciprocating Pump Stuffing Box

Gary Dyson

CLYDEUNION Pumps

Mike Bixler

CLYDEUNION Pumps

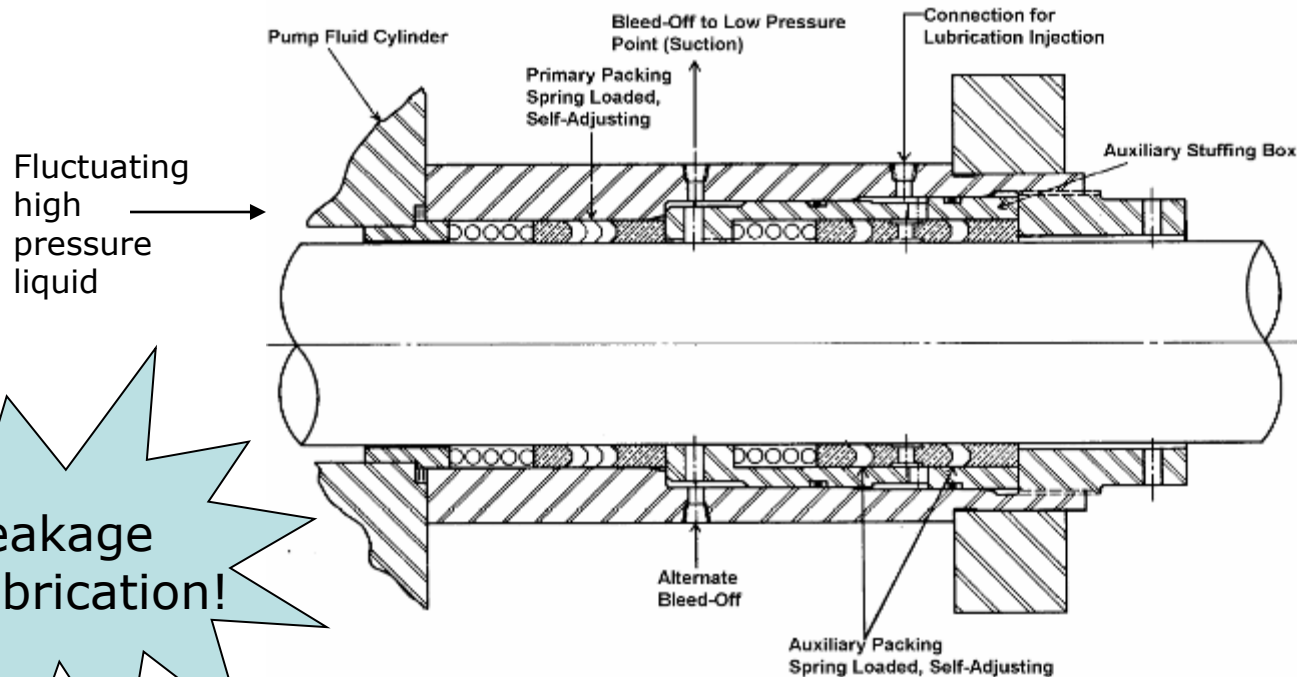
Paul Brown

Enterprise Products

# Packing Problems on Reciprocating Pumps

## ■ The Problem

- Packing MUST leak
- The leakage through the packing is essential to ensure long packing life as it provides lubrication as the plunger moves through the packing
- Current state of the Art allows this leakage outwards through the packing but then collects it through a bleed off connection
- Due to the reciprocating nature of the pump the pressure to be sealed experiences a sinusoidal pulsation
- This pulsation can cause excess leakage as the packing can further wear as it shuttles in the stuffing box
- Any particles in the pumped product can be dragged through the packing causing greater wear



Leakage  
Is lubrication!

## ***Technical and Environmental Challenges***

---

- Prevent leakage out of the pump through the stuffing box
- Ensure that reciprocating plunger pumps can meet the EPA mandated emission values
- Extend or maintain high packing life
- Can be fitted to existing machines
- Easy to operate and maintain

# Classification of Patents – Approach to solving the problem

- Level 1 Simple solutions

Achievable through normal engineering

- Level 2 System improvements

Similar systems in one industry

- Level 3 Inventive solution

Resolved in one discipline e.g. mechanical engineering

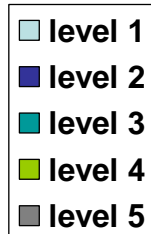
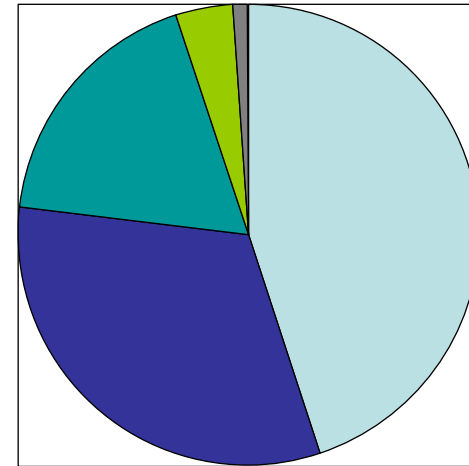
- Level 4 Significant Invention

New design may require interdisciplinary techniques

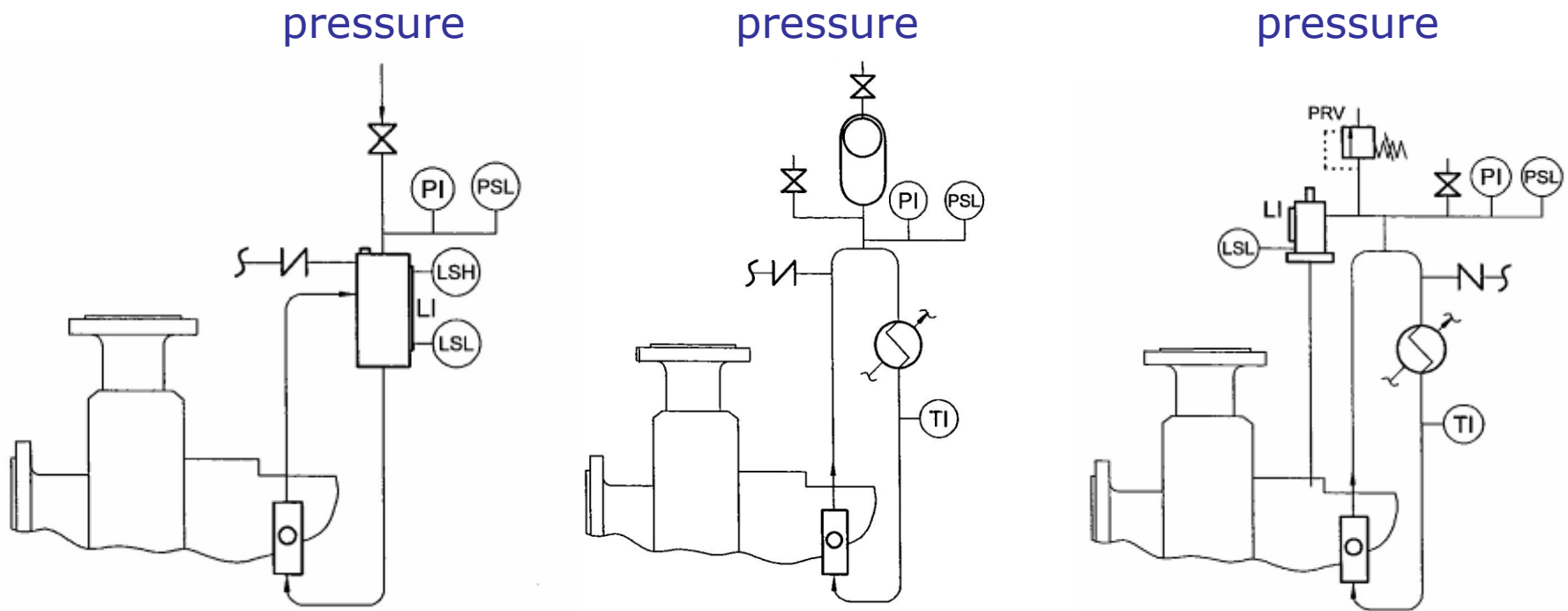
- Level 5 new phenomena

New discovery

**Very Few Ideas are completely new so look extensively at existing solutions from other similar applications**



# Centrifugal Pump Analogy

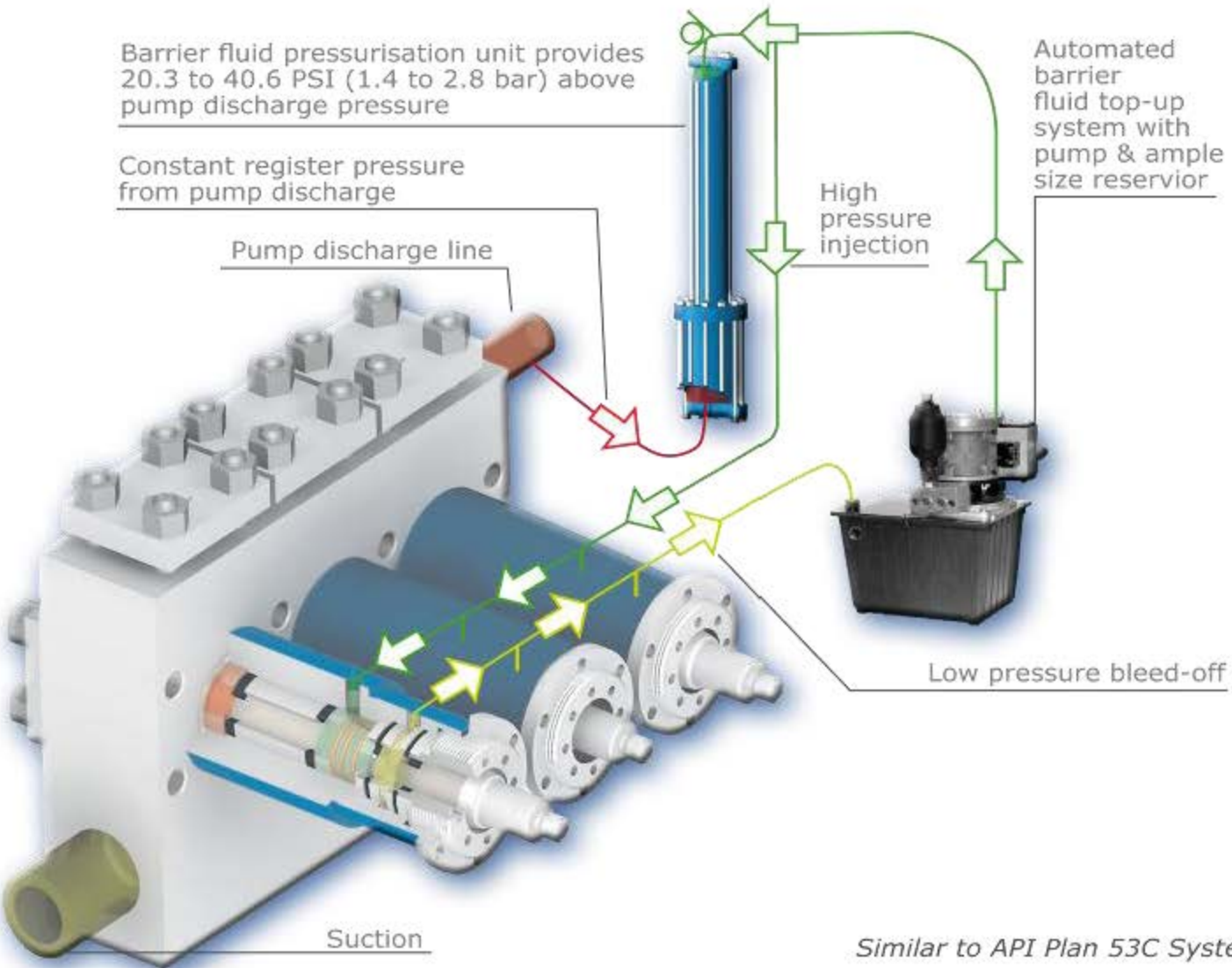


The world of Centrifugals solves the problem by forcing leakage INWARDS

**Can we apply this to a reciprocating pump with fluctuating pressure?**

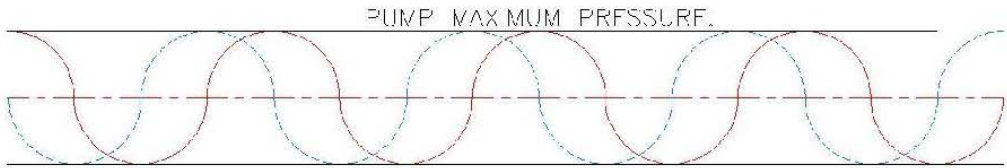
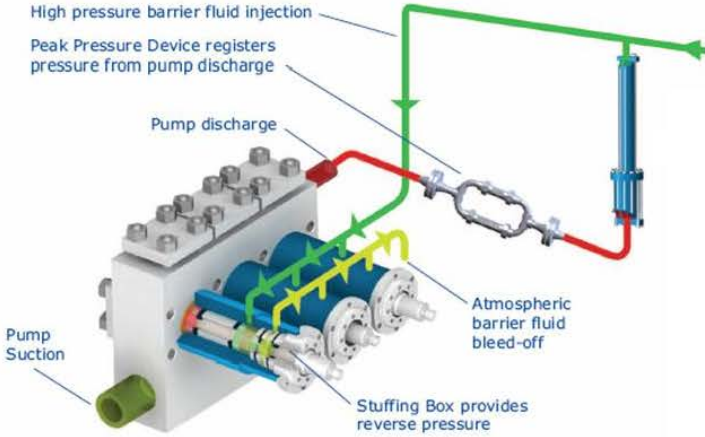
**Plan 53C for Reciprocating Motion!**

# The Concept



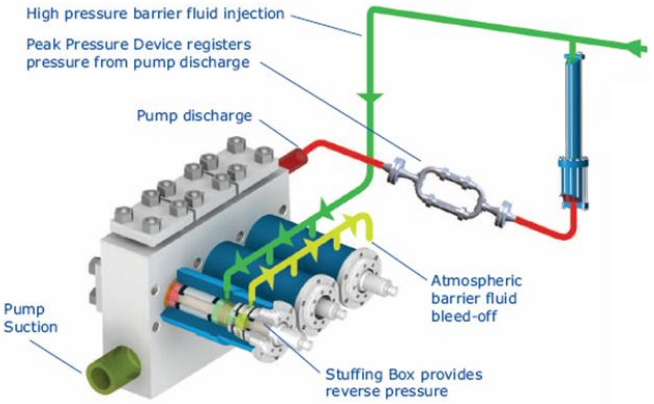
*Similar to API Plan 53C System*

# Smoothing and referencing the maximum pressure



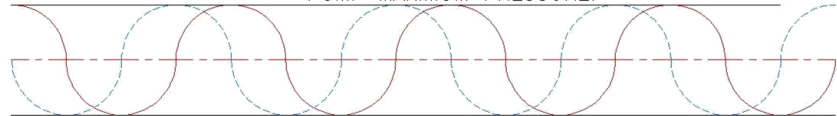
Pressure pulsations regulated by check-valves

# Adding Pressure between the inner and secondary seal

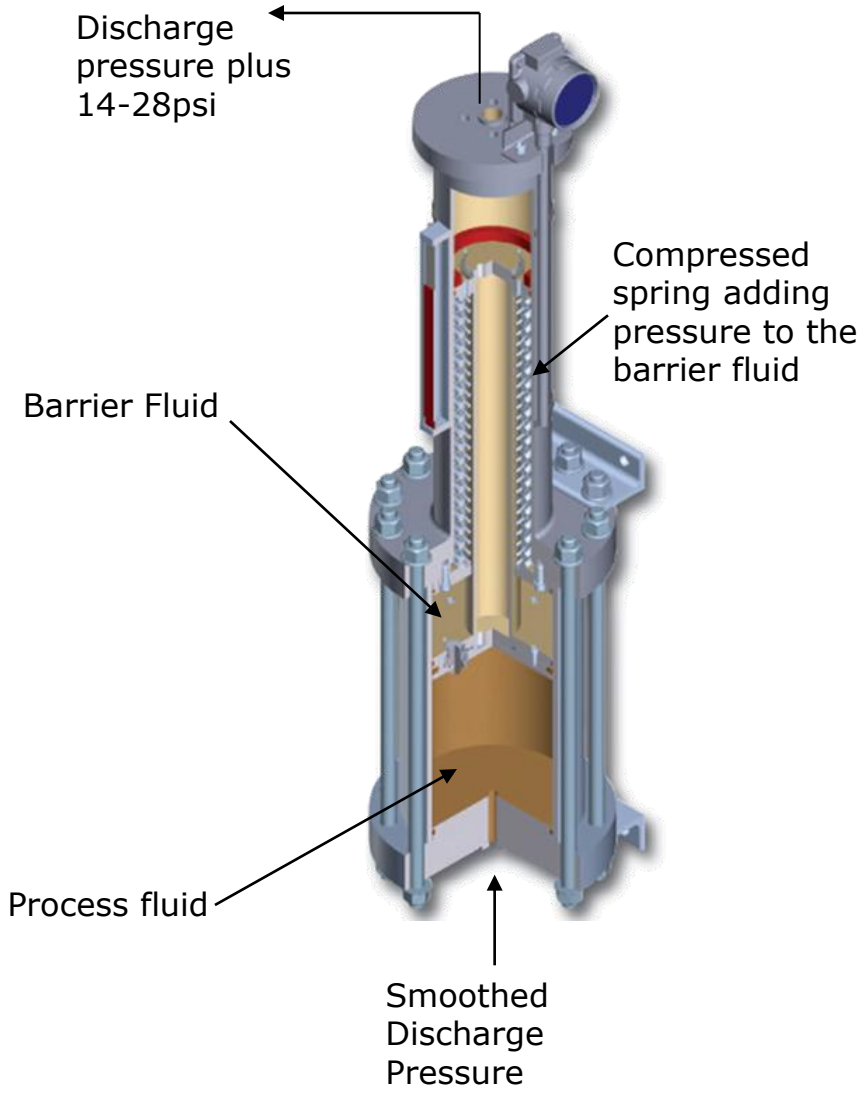


STUFFING BOX MAXIMUM PUMP PRESSURE plus 14 to 20 PSI.

PUMP MAXIMUM PRESSURE.

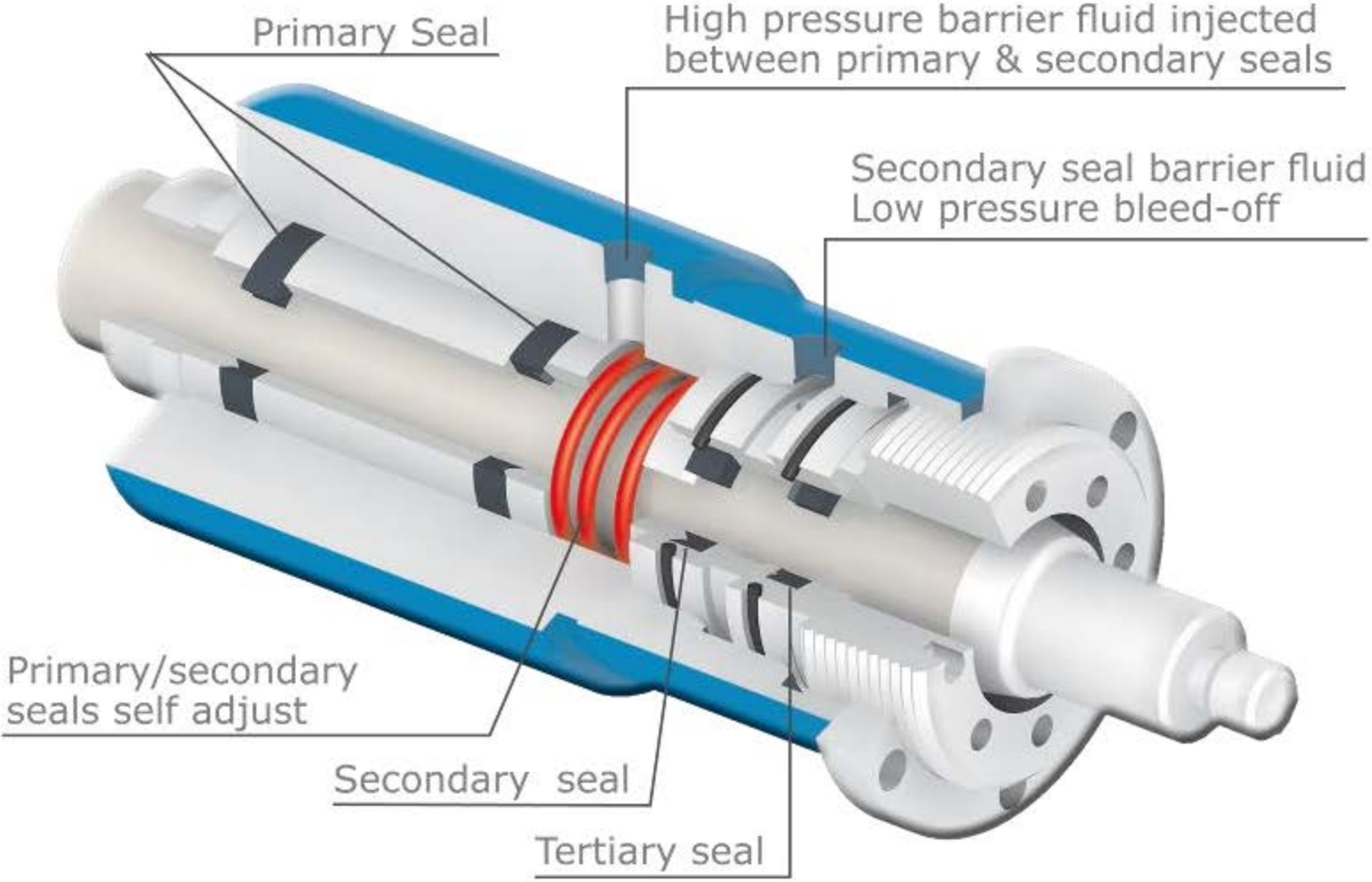


Patented spring loaded pressure addition system references the discharge pressure and adds 14-28 psi to this pressure in the barrier fluid via the spring compression



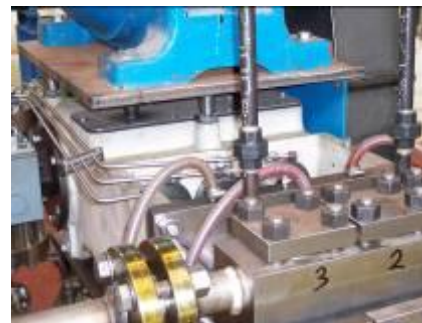
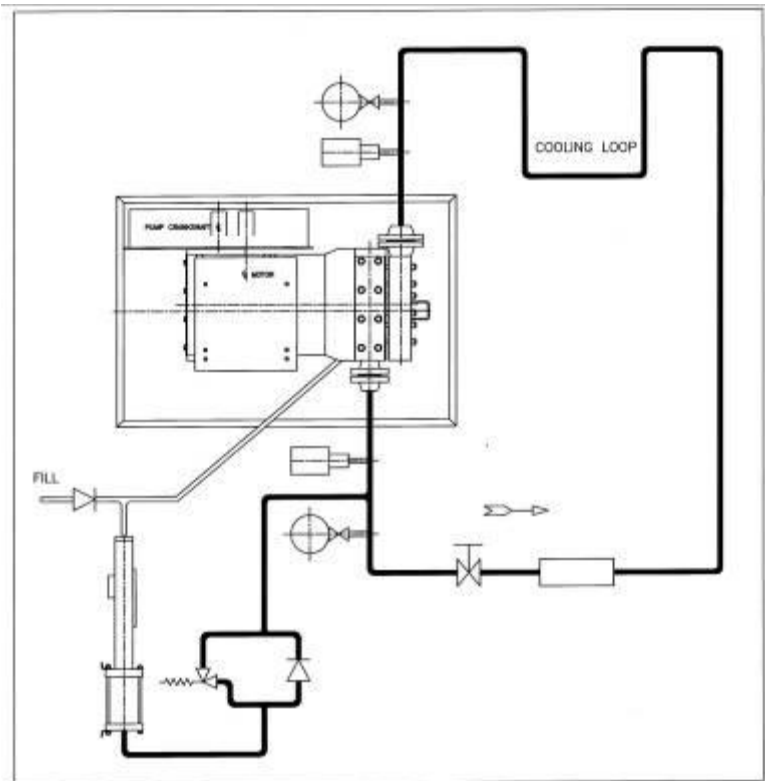


# Stuffing Box Design

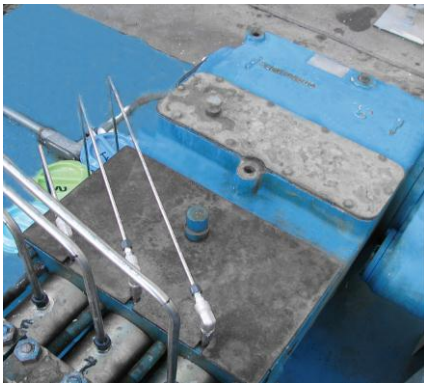


# Concept proof and R&D testing

- 4 weeks constant testing
- Critical elements – packing configuration
- Leakage evaluation over multiple configurations



# Site Trials – Enterprise Products; Port Allen Facility



Day	Date	Time	Pump Flow Rate BPD	Pump RPM	Suction Pressure PSIG	Disch Pressure PSIG	CP Tank Register Pressure PSIG	Ambient Temp. °F	Suct. Pipe Temp °F	Disch Pipe Temp °F	Stuffing Box Surface Temperature °F			Sniff Test Readings ppm			CP Unit Flng Movement			Collected Gland Leakage		Day Tank Level Gallons
											Box 1	Box 2	Box 3	Box 1	Box 2	Box 3	No. of Flngs from Full	Last Fluid Ozs.	Remaining Fluid Ozs.	ml	Ozs.	
Mon.	22/Nov/10	7:50 AM	373	126.2	264	840	860	68	76	78	87	91	88	165	165	79	13.50	184.55	78.60	10	0.34	12.50
Tues.	23/Nov/10	7:40 AM	203	68.7	264	860	880	70	79	79	85	86	87	N/A	N/A	N/A	1.50	20.51	242.64	10	0.34	12.00
Wed.	24/Nov/10	8:10 AM	440	148.9	256	880	900	70	78	80	83	88	87	74	134	98	7.50	102.53	160.62	10	0.34	11.25
Thur.																						
Fri.																						
Mon.	29/Nov/10	7:15 AM	140	47.4	255	970	980	61	69	70	76	78	79	N/A	N/A	N/A	3.50	47.85	215.30	250	8.45	8.50
Tues.	30/Nov/10	7:00 AM	190	64.3	256	900	990	56	62	62	70	71	70	74	89	50	7.50	102.53	160.62	300	10.14	8.50
Wed.	01/Dec/10	6:55 AM	56	18.9	246	680	700	34	50	50	55	59	58	N/A	N/A	N/A	12.75	174.29	88.85	300	10.14	7.00
Thur.	PUMP DOWN																					
Fri.																						

- Site Trial on Butane Pump with a history of emissions problems and poor packing life
- Individual systems installed on each stuffing box
- Monitored regularly

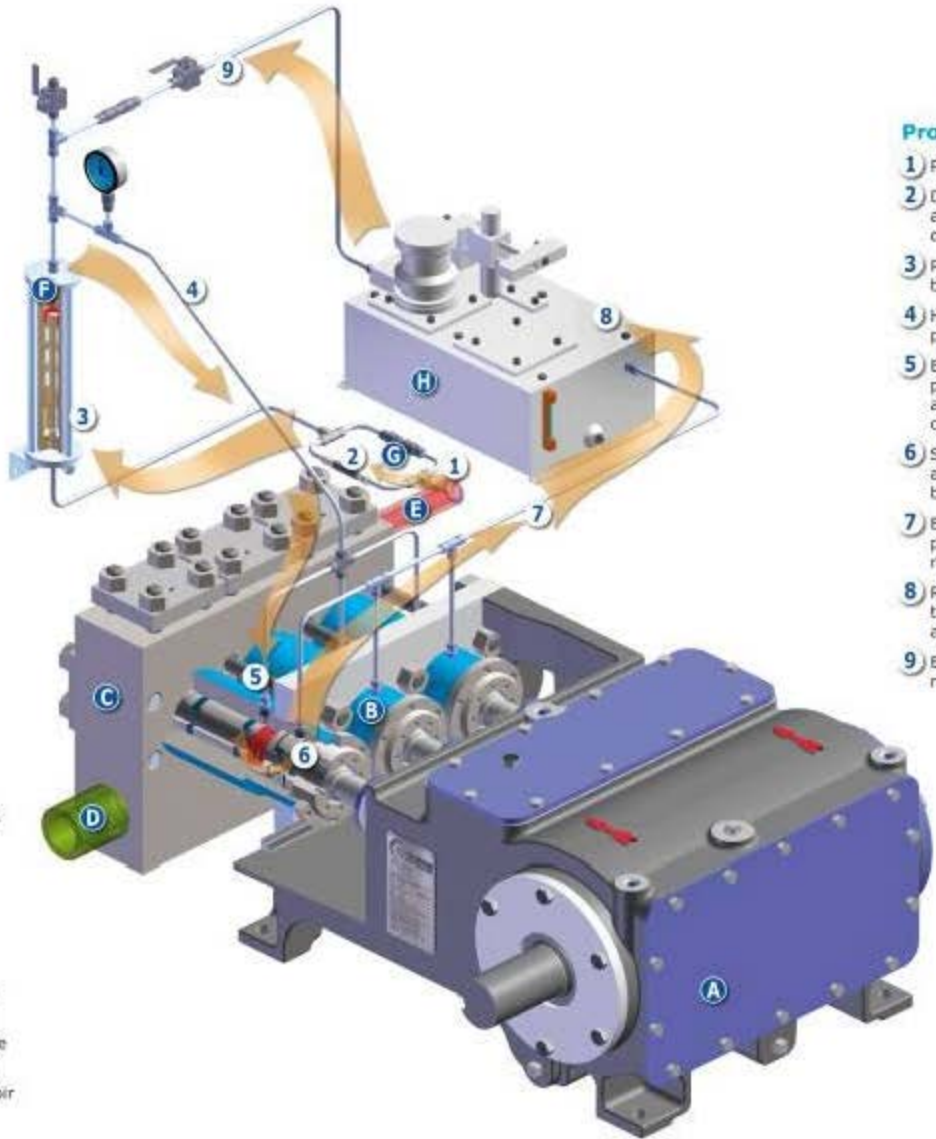
# Site Testing



- Fugitive emissions were virtually eliminated by this packing arrangement



# Final Design Configuration



- Equipment**
- A** Reciprocating Pump Power end
  - B** Stuffing Box
  - C** Fluid end
  - D** Suction
  - E** Discharge
  - F** Pressurising device
  - G** Device to monitor Peak pressure of the discharge pulsation
  - H** Auto top-up reservoir

- Process**
- 1** Pulsating pressure at the pump discharge
  - 2** Device to monitor the peak of the pressure pulsation and pass this pressure through to the pressurising device
  - 3** Pressurising device designed to add pressure to a barrier fluid at 2bar above peak discharge pressure
  - 4** High pressure barrier fluid output from the pressurising device
  - 5** Barrier fluid injected between first and middle packing sets to ensure leakage through packing is always inwards into the process fluid rather than outwards to atmosphere
  - 6** Stuffing box with packing sets, the inner set seals against the process fluid and middle set seals barrier fluid against atmosphere
  - 7** Excess barrier fluid that exits through the middle packing set is sealed with the outer packing set and returned to a reservoir
  - 8** Reservoir containing a auto top-up device ensures that barrier fluid levels in the pressurising device are maintained.
  - 9** Barrier fluid is returned to the pressurising device to maintain barrier fluid levels

Questions?