The Elimination of VOC Emissions from a Reciprocating Pump Stuffing Box

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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

[Diagram of packing system with labels and annotations]
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**

Barrier fluid pressurisation unit provides 20.3 to 40.6 PSI (1.4 to 2.8 bar) above pump discharge pressure

Constant register pressure from pump discharge

Automated barrier fluid top-up system with pump & ample size reservoir

High pressure injection

Low pressure bleed-off

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

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.
Primary/secondary seals self adjust

High pressure barrier fluid injected between primary & secondary seals

Secondary seal barrier fluid
Low pressure bleed-off

Secondary seal

Tertiary seal
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

- 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

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

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
Questions?