

# **The True Cost of External Seal Flush (Piping Plan 32)**

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A change of mechanical seal flush plan improved the efficiency of the plant. The dilution effects of a plan 32 flush had an impact on the efficiency of downstream evaporator plant. By using an alternate seal arrangement the flush was no longer necessary. As the plant was a batch production process this resulted in a significant reduction in plant running hours and power consumption. Any business operating pumps on evaporator systems needs to consider with great care the piping plan used on the pump seals.



## Background

This case study come from a Scottish whisky distillery.

Scotland forms the most northerly part of the United Kingdom. Covering an area equivalent of South Carolina and a population size of Arizona Scotland is at the same latitude as southern Alaska. Scotland's primary exports include Oil and Whisky production. With over 100 distilleries the industry represents over 20% of the countries earnings.

## Scotch Whisky Production

- Over 110 active distilleries in Scotland
- Process not dissimilar to ethanol production
- Alcohol – Malted Barley
- Process
- Mashing (Wort)
- Fermentation (Beer)
- Distillation - Copper Kettle
- Maturing - Oak barrels min 3 yrs by law



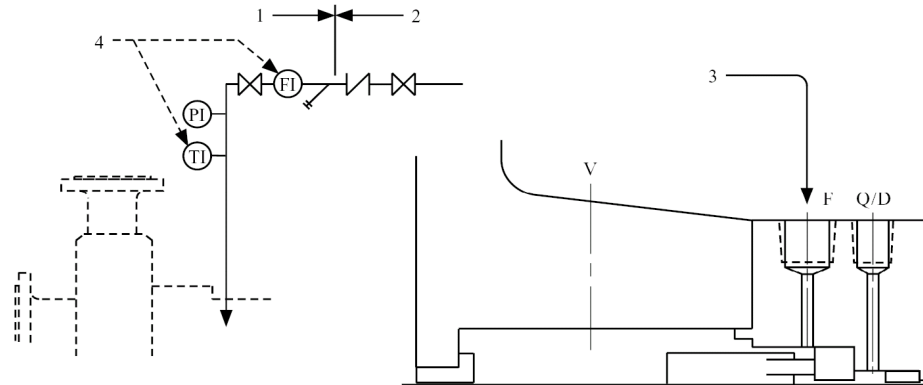
### Process

Scotch Whisky is made from malted barley, the distillation process is similar to ethanol production. However complex flavors are imparted by the malting process, the unique shape of the distillation kettles and aging in used oak barrels.

## **Application Background**

- Spent lees are the by-product of the steeping process
- Once evaporated to a syrup - sold as an animal feed
- Evaporator plant used end suction 3 Pumps
- Pumps were fitted with Plan 32 Seal Flush
- The evaporator plant efficiency was in question
- Unable to keep pace with production
- Efficiency improvements were required
- Seal flushes were considered a potential cause of inefficiency

## Problem Analysis API Plan 32



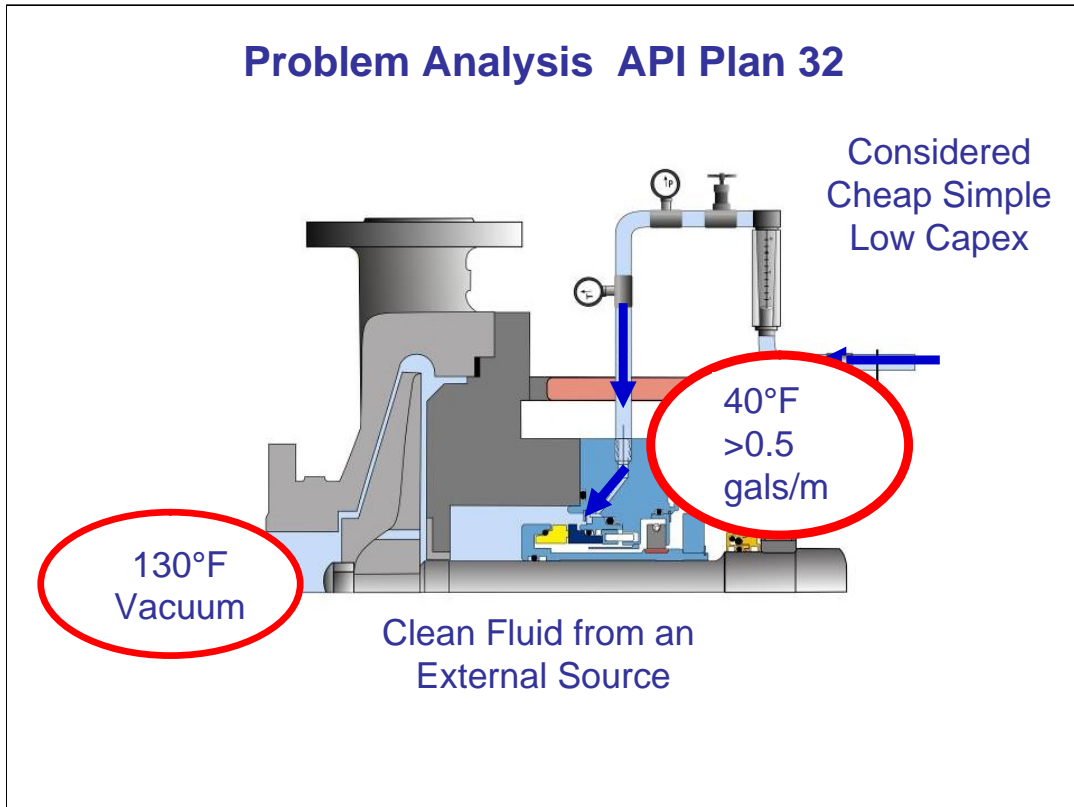
Flush is injected into the seal chamber from an external source.

Three evaporator circulation pumps were fitted with single mechanical seals and a simple Plan 32 flush. Plan 32 provides a clean fluid from an external source to flush the seal chamber. This plan provides improved seal reliability. The API 682 standard states that the plan is used to exclude solids or contaminants, reduce the temperature at the seal, reduce flashing & air intrusion across the seal faces.

The plan is also favored as the installation costs (capital expenditure) is low. An abundant supply of fresh water would have also influenced the selection of this plan

The reliability of the single seal was affected by the security of the flush. Failures of the flush have caused seal failures. The installed system was also flawed in that there were no proper flow controllers and indicators installed to the flush.

## Problem Analysis API Plan 32



However the impact of plan 32 on evaporator system efficiency was not an initial consideration. This was the plant primary reason for investigating alternate sealing methods as the evaporator was running at its limit .

The syrup fed to the evaporator was being diluted by an estimated 0.5 gals / min, per pump of flush fluid. This estimate was considered conservative by operation personnel on the site. The addition of flush liquid into the process meant having to evaporate more liquid. The injected flush water came from a cold mountain stream source at 40°F, so more heat was being added to the process to maintain evaporation temperature.

## Problem Analysis API Plan 32

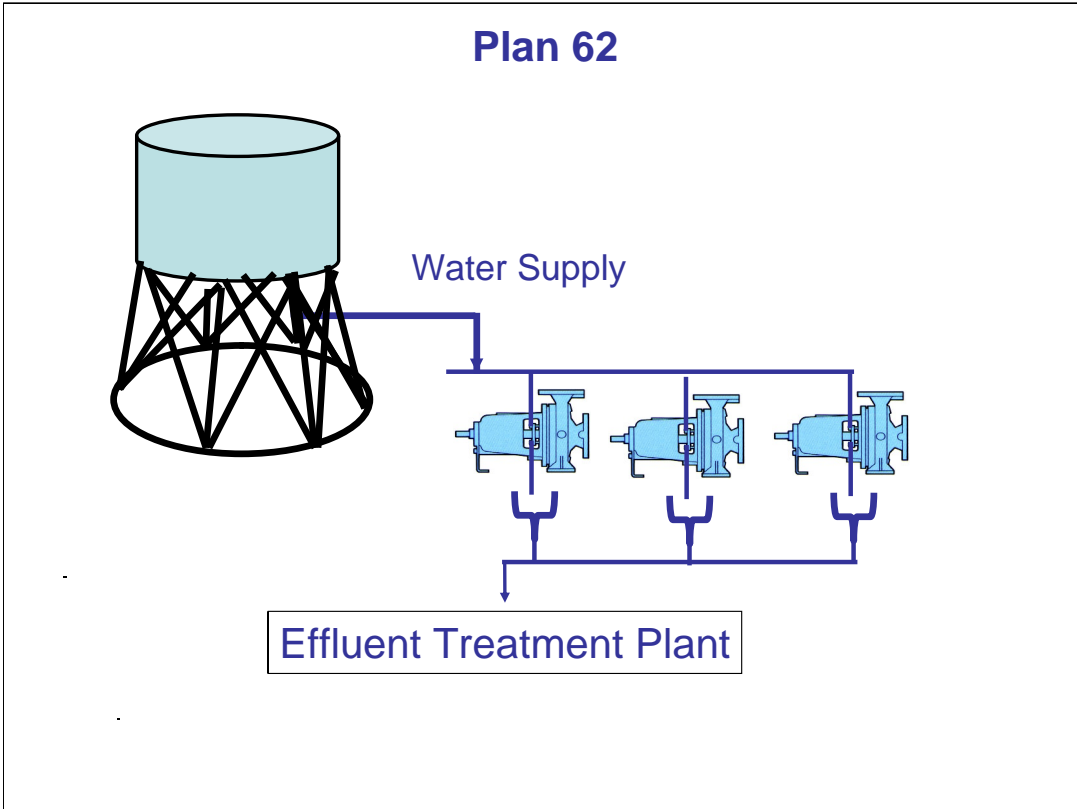
- Consider Evaporator Efficiency
- Feed Stock Syrup Approx 40 gals min
- 3 Pumps. Combined Seal Flush > 2gals min
- 40°F
- 40°F to 130°F 19kW 450 kW.hr / day
- Evaporation **5700 kW.hr / day**

Heating the cold flush water to the evaporation temperature required 19 kW, or 460 kW-hr per day. Evaporating the flush water requires over 200kW or 4800 kW-hr per day.

## **Options Considered**

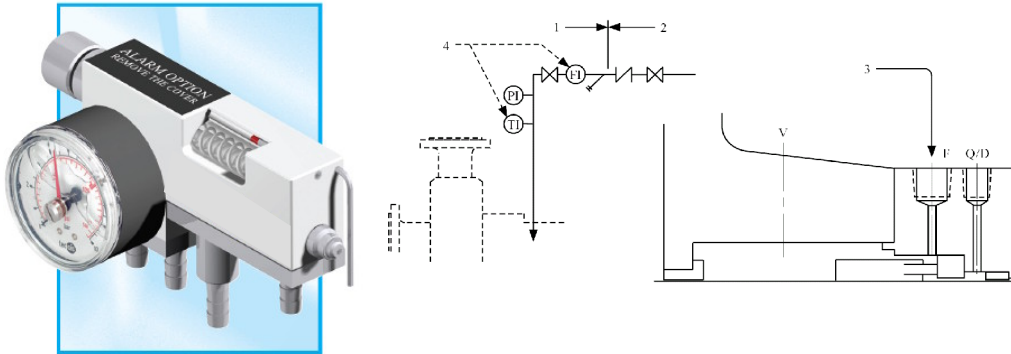
- Plan 62 Quench Single / Dual Seal
- Plan 32 with better Flow Control
- Plan 54 + Dual Seal
- Plan 53a + Dual Seal
- Plan 53a – Modified + Dual Seal





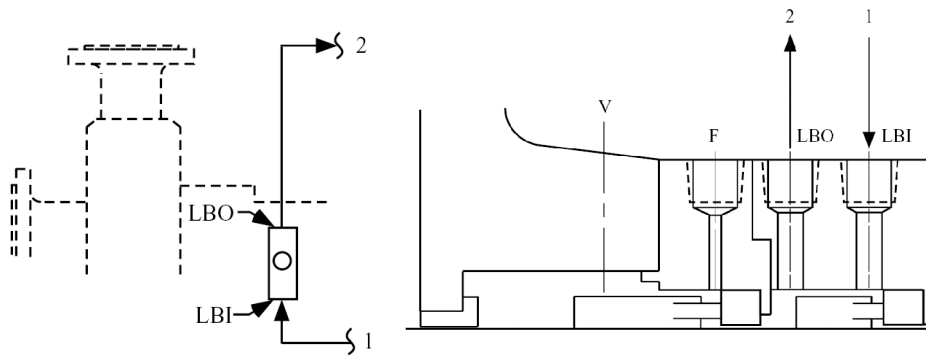
Plan 62 Dismissed. The Distillery was trying to reduce environmental impact and effluent treatment disposal was a key issue

## Improve Plan 32



Dismissed. Flush flow may be controlled and operator error eliminated, however, difficult to control less than  $<0.25$  Gals / min

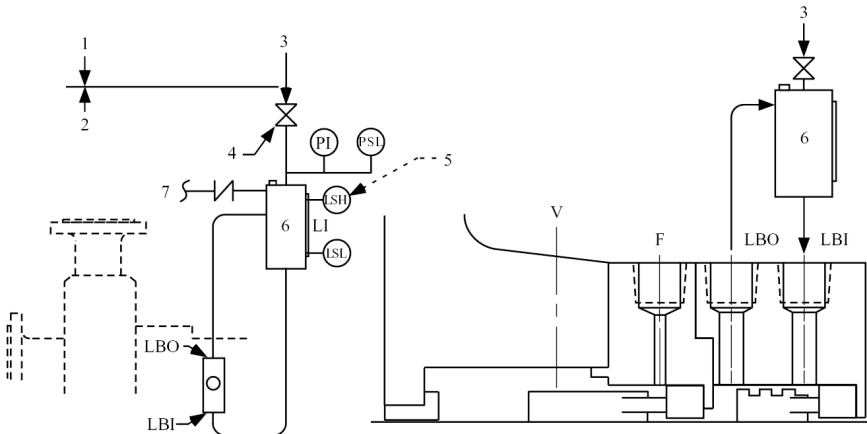
## Plan 54



Pressurised external barrier fluid reservoir or system supplying clean fluid to the seal chamber. Circulation is by an external pump or pressure system. Reservoir pressure is greater than the process pressure being sealed.

Plan 54 Dismissed as complex and costly

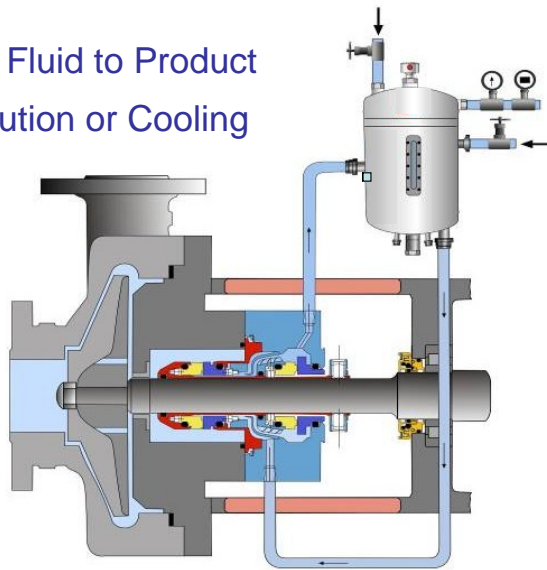
# Plan 53A



Pressurised external barrier fluid reservoir supplying clean fluid to the seal chamber. Circulation is by an internal pumping ring. Reservoir pressure is greater than the process pressure being sealed.

## Alternate Plan 53A + Double Seal

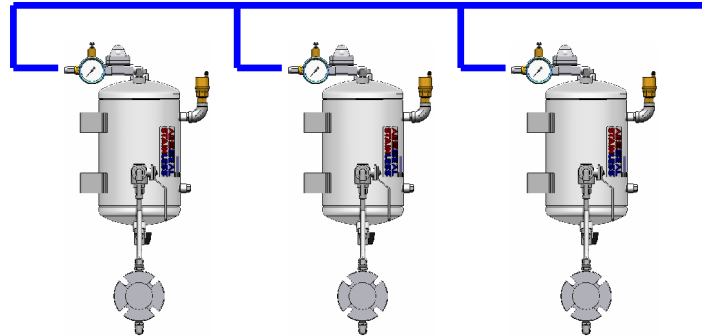
No Loss Flush Fluid to Product  
No Product Dilution or Cooling  
No Effluent



Conversion to a double seal system with an adapted plan 53A would eliminated the need for seal flush. The pressurized barrier fluid provides a clean liquid environment for the inner seal faces and prevents air intrusion to the vacuum. The classic 53A systems need to be monitored and if necessary manually topped up. With low levels of manning on site there were concerns that operators would not maintain the liquid levels. Alarms and switches were considered undesirable due to cost and complexity

## Alternate Technologies Water Management Systems Based on plan 53a

Existing Plant Water System  
Plan 32



An alternative to this system was proposed and accepted by the distillery. The barrier system used is similar to API plan 53a. However the existing plan 32 Water supply is connected so as to both pressurise and maintain the level in the tank, no manual intervention is then required, and maintenance costs are reduced. An air space in the top of the vessel serves as an expansion volume, minimizing the effect of temperature changes. In the event of water supply interruption, the air volume and a check valve maintain pressure until supply is resumed. This systems is self contained, and has the advantages of the traditional 53a.

## Results

- Evaporator from 88 to 98 tons per hr
- 11% Output
- 10% Reduction in hours



Using this new arrangement, initial trials were undertaken on one pump. An immediate performance increase in the evaporator was noticed. The trial was concluded after one week with subsequent pumps converted the following week. Syrup production increased from 88 to 98 tonnes / hr, this resulted in a significant reduction in plant running hours. In addition, over 5000 kW-hr of energy was liberated. Seal reliability improved and no failures have been experienced since installation in 2003.

## Potential Lessons

- Any process business that uses plan 32 seal flushes needs to consider greater economics.
- Product dilution is only one effect. Thermal implications can effect overall plant energy efficiency
- If there is an evaporation process downstream of a plan 32 then efficiency losses are likely to be very substantial
- Total cost of equipment ownership and reliability should also consider plant efficiency and operating costs.

Any business operating pumps on evaporator systems needs to consider with great care the piping plan used on the pump seals.