OIL COMPANIES INTERNATIONAL MARINE FORUM

INERT GAS SYSTEMS
SEMI-DRY TYPE DECK WATER SEALS

Prevention of Inert Gas/Hydrocarbon Backflow

The OCIMF mission is to be recognised internationally as the foremost authority on the safe and environmentally responsible operation of oil tankers and terminals.

The Oil Companies International Marine Forum (OCIMF) is a voluntary association of oil companies having an interest in the shipment and terminalling of crude oil and oil products. OCIMF is organised to represent its membership before, and consult with, the International Maritime Organization (IMO) and other government bodies on matters relating to the shipment and terminalling of crude oil and oil products, including marine pollution and safety.

INTRODUCTION

The inert gas system (IGS) deck seal arrangement and additional mechanical non-return devices are intended together to form the means whereby the backflow of hydrocarbon gases from the cargo spaces to the ship's machinery space is automatically prevented. This document investigates the operation of the semi-dry type deck water seal and its effectiveness in preventing such a backflow of inert gas and/or hydrocarbon vapour.

There have been a number of such incidents reported within the OCIMF membership which suggests that it is possible, given certain modes of failure of equipment, for such a backflow of potentially hazardous vapours to occur.

This paper, which is a sister paper to the currently available OCIMF publication entitled "DRY TYPE DECK WATER SEALS", will present the current international requirements for inert gas system (IGS) non-return devices, examine the operation of semi-dry type deck water seals, identify potential modes of seal failure and propose equipment modifications which may prevent the potentially hazardous backflow of inert gas and/or hydrocarbon vapour to gas safe spaces.

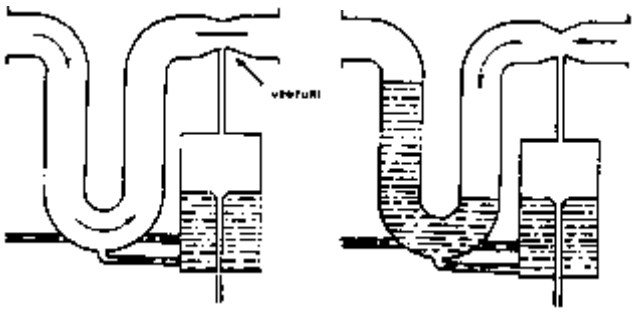
REQUIREMENTS FOR IGS NON-RETURN DEVICES

SOLAS Chapter II-2, Regulation 62, requires the installation of two non-return devices, one of which shall be a water seal, in the inert gas main of any inert gas system. This regulation also requires that the arrangement of the deck water seal is such as to prevent the backflow of hydrocarbon vapours and ensure the proper functioning of the seal under all operating conditions.

The International Maritime Organization (IMO) publication "Guidelines for Inert Gas Systems", Sections 3.6 and 3.7, indicates the design considerations and provides details on the function of various types of deck water seals.

OPERATION OF SEMI-DRY DECK WATER SEALS

The semi-dry deck water seal has a separate holding chamber which is connected by pipe to the inert gas main via an eductor. Instead of passing through a water trap, the inert gas flowing through the venturi creates a suction effect in the holding tank which draws the sealing water from the loop seal into the holding tank. This mitigates the undesirable 'carry over' of moisture to the cargo tanks. Figure 1.0 shows a simplified sketch of this type of seal.



Gas Flow Towards Cargo Tanks Back Pressure in Cargo Tanks

Figure 1.0 Semi-dry type deck water seal.

When the gas flow ceases, the venturi effect is lost and the water from the holding tank rapidly flows back into the inert gas main loop seal thus creating a water seal which serves to prevent the backflow of hydrocarbon vapour and/or inert gas from the hazardous to non-hazardous area.

SEAL FAILURE MODE - BACKFLOW

The efficacy of the semi-dry type deck water seal as a protective device against backflow requires that all associated equipment is in first class condition and being operated correctly. The experience of OCIMF members suggests that around 90% of occurrences of reduction in seal effectiveness can be attributed to the following:

- blockage of the venturi pipeline by scale or debris causing the holding tank to be partly or fully isolated from the inert gas main. In this case the holding tank pressure will be lower than that of the inert gas main thus preventing water from entering the loop. In the event of the inert gas system being shut down for any reason, hydrocarbon vapour will be able to backflow towards the engine room.

- blockage of the pipeline connecting the holding tank to the seal loop in the inert gas main will also prevent the water from the holding tank to freely flow into the loop in the event of the inert gas system being shut down. Once again the consequence will be for hydrocarbon vapour to backflow towards the engine room.

In both these circumstance, should the deck mechanical non-return valve also be faulty it is highly likely that hydrocarbon vapour and/or inert gas will be able to flow from the hazardous area to the non-hazardous area.

PROPOSED MEASURES TO REDUCE THE RISK OF BACKFLOW

The risk of hydrocarbon vapour and/or inert gas backflow can be significantly reduced by ensuring that a proper and effective maintenance regime is adopted **and followed** on board the ship. Such a regime should allow for:

- frequent physical and visual inspection of those pipelines which have potential for blockage or corrosion to ensure that water may freely flow through them and their integrity is not impaired due to corrosion. Whilst it is appreciated that this recommendation may involve removing sections of pipeline, it is suggested that this inconvenience is insignificant when compared to the potential for a serious incident should the deck seal fail to operate.

- checking the diameter of the pipeline connecting the venturi to the holding tank with a view to increasing it to ensure the opportunity for blockage is reduced. Similarly the diameter of the pipeline from the holding tank to the seal loop in the inert gas main should be checked to ensure it is adequate to allow rapid transfer of water to the loop in the event of a cessation of inert gas flow. It is strongly recommended that any alterations to the diameter of these pipelines is made only after a proper technical investigation or consultation with the manufacturer of the seal.

- the selection of materials used in critical pipelines to be such as to avoid blockage due to internal corrosion. Critical pipelines should also be installed in such a way as to facilitate removal for inspection. The installation of a trap at the connection between the seal loop and the pipeline to the holding tank should reduce the possibility of debris from the inert gas pipeline blocking the smaller diameter pipe.

INSTRUMENTATION TO AUGMENT SEMI-DRY TYPE WATER SEALS

The risk of hydrocarbon backflow can be further reduced by the provision of additional monitoring equipment to enhance the operations of the inert gas system which includes a semi-dry type seal. It is acknowledged that the additional equipment will increase the complexity of the system and the overall maintenance workload and this should be taken into account by individual operators when making the decision to enhance the existing system or replace the deck seal for another.

The following monitoring equipment options should be considered as having the potential to enhance the safety of operation of the deck seal. Individual operators should decide which, if any, would enhance the safety of their particular system.

a) Deck Main High Pressure Shutdown

This device can reduce the risk associated with gas/hydrocarbon backflow by shutting the inert gas system down when the deck main cargo tank pressure exceeds a predetermined level, e.g. 1,400mm W.G.. Alternatively, a pressure release control system which vents the excessive pressure to a safe area could be considered. Currently SOLAS requires only the provision of a high pressure alarm. Indication of a high pressure shutdown should be provided in the Cargo and Engine Control Rooms.

b) Differential Pressure Alarm Shut Down

This device will sense the difference between the pressure in the pipeline upstream of the pressure regulating valve and the pressure in the I.G. main. If the pressure of the I.G. main is equal or higher than the pressure upstream of the control valve, the system will shut down automatically and close the gas regulating valve. Indication of this condition should be provided in the Cargo and Engine Control Rooms.

Measuring points should be arranged to prevent hydrocarbons entering the hazardous area through sensing pipelines. This is normally accomplished by the use of secondary monitoring loops. A timing delay should be incorporated to allow the inert gas blower to start with zero differential pressure. During this period, the pressure regulating valve will be closed.

c) Atmospheric Vent Valve

The purpose of this valve is to rapidly open when the inert gas system is shut down. In operation it will be timed to open when the I.G system is shut down and the pressure regulating valve automatically closed. This valve should be installed between the deck seal and the inert gas pressure regulating valve thus allowing the section of inert gas main between these two equipments may be relieved of pressure and constantly vented to atmosphere.

The valve should be power operated and arranged to 'fail safe' i.e. powered to close with a return spring to open. Remote indication of the valve position should be provided in the engine and cargo control rooms. It is recommended that the valve and vent pipeline diameter should exceed 100mm.

Note: A means to vent the portion of the inert gas main between the deck water seal and the inert gas pressure regulating valve is required by SOLAS for systems built on or after 1st June, 1981. However, there is no requirement regarding the size of the valve or vent pipeline. The above recommendation for valve and pipe diameter is made to ensure that a large quantity of gas can escape in a short time period and reduce the possibility of a build up of pressure in this section of the I.G main.

d) Power Operated Deck Main Isolating Valve

It is recommended that this valve be arranged to close automatically in the event of a normal, alarm or emergency shutdown thus increasing the overall safety of the system by preventing hydrocarbon backflow. The valve operation should be 'fail safe', i.e. power to open and a spring arrangement to close. Open/Close limit switches should be provided to give indication of the valve position to the Engine and Cargo Control Rooms.

e) Deck Main Non-Return Valve With Disc Position Indicator

Should the existing system not have such a valve it is recommended this valve be equipped with a direct mechanical disc position indicator and a means to check its operation manually. A test valve should be installed upstream of the non-return valve to allow periodic checks for leakage.

f) Deck Seal Water Supply Low Pressure (or Flow) Alarm

A low water pressure (or flow) alarm should be installed in the water supply pipeline to the deck seal to ensure the seal has an adequate supply of water available at all times. This monitoring device, which will augment the low water level alarm required by the SOLAS Convention should be maintained in operation even when the inert gas system is not in use.

g) Ultrasonic Type Level Sensors

Mainly because these sensors require less maintenance than the conventional float type, they are recommended as direct replacements for existing float sensors.

The above recommendations should serve to enhance the safety of operation of the semi-dry type deck water seal. However it is strongly recommended that **all types of deck water seals** be regularly inspected to ensure that there is no internal corrosion which could result in hydrocarbons bypassing the water seal and entering the non-hazardous area. In addition, any corrective maintenance required as a result of such inspections should be promptly carried out.

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