OilPro Oilfield Production Equipment Ltd.
202, 1201 Fifth Street S.W.
Calgary, Alberta
T2R 0Y6
CANADA

The Innopipe Inline Separator and Piggable Drip

By Miles E. Haukeness P.Eng

Introduction:

Natural gas transmission pipelines often contain liquids that can interfere with the proper operation of the pipeline and related equipment such as compressors, regulators, filters, meters and valves. The liquid contaminants normally include hydrocarbon condensations, lubrication oils, produced water, and chemicals used in production, treatment, compression or dehydration of the gas.

Traditional "Drips":
Gas transmission pipelines have typically used below grade liquid separators known as "drips" that are installed in the pipeline at regular intervals to collect the liquids carried in a gas stream. These drips that are currently in use are not effective at transmission velocity gas flow rates as they must be designed to allow passage of a tool called a Pipeline Inspection Gauge ("pig").

The Problem:
The piggable drip designs would capture only liquids which flowed along the base of the pipe (low velocity stratified flow) while liquids flowing on the outside of the pipe wall (as in high velocity annular flow) would bypass.

The Solution;
The new Innopipe Piggable Drip has been developed to be both piggable and efficient at liquids separation even at transmission gas velocities. The Innopipe Piggable Drip utilizes a patented process where an annular gas stream separation technique is used to remove all the liquids with the least amount of gas and is successful at all gas flow stream velocities.

Overview:
The typical flow regime in high-pressure natural gas streams is two phase annular flow where liquids flow in an outer ring near the inside surface of the pipe wall. The Innopipe Piggable Drip separates the annular flow stream, which contains all the liquids, from the primary gas stream. This secondary gas stream is only approximately 5% of the primary flow and is directed to a collection reservoir where final separation can occur. The remaining 95% of the primary gas stream that is inherently liquid-free passes through the separator untouched. The liquids are easily removed from the smaller secondary flow and the cleaned gas is re-

combined downstream.

The Advantages:
The distinct advantage of annular flow separation is that only a relatively small secondary flow is required and all the free liquids in a gas stream are removed. This allows the Innopipe Piggable Drip to maintain high separation efficiency even at maximum gas flow rates (when liquids are more likely in motion). As pipelines experience higher flow rates, traditional drips are bypassed and conventional separators cannot slow the primary gas stream velocity sufficiently.

The Results:
The Innopipe Piggable Drip design eliminates the need to reduce the flow rate of the primary gas flow and the result is significantly savings in piping and vessel size requirements. The design is also easily piggable when the secondary flow is interrupted and is fully bi-directional.

The Innopipe Piggable Drip has the potential to become the "standard" liquids separation removal device for the Natural Gas Industry as a transmission pipeline drip and offers an efficient and cost-effective alternative to conventional well stream separators. The Innopipe Piggable Drip design represents a significant milestone in applied liquids separation technology for natural gas producers, pipeline and compressor station operators.

HOW IT WORKS:
The Innopipe Piggable Drip (see attached figures) has two parts: a flow separator and a collection reservoir. The flow separator comprises of a pipe the same size as the natural gas line pipe surrounded by a shell to form an annular chamber. The annular chamber is divided into two halves by a pressure tight baffle and each as an inlet/outlet through slotted apertures. The slots are barred to provide support for pigging tools.

At the inlet to the flow separator the natural gas stream gas is separated into two streams;

(1) a primary flow that continues down the internal pipe of the separator and,

(2) a secondary flow of gas containing all the liquids in annular flow being drawn into the annular chamber.

This secondary flow rate in the annular chamber is approximately 5% of the flow rate of primary gas stream and is directed through the separator outlet nozzle to the inlet of the collection reservoir. The 5% secondary flow rate ensures that all liquids are entrained in the secondary flow stream and the remaining primary gas stream is free of liquids. Production field gathering lines can have up to a volumetric liquids to gas ratio of 1% (100 bbls/MMSCF) where as transmission pipelines normally experience a maximum of liquids to gas ratio of 0.001% (40 lbs/MMSCF).

The collection reservoir removes the liquids from the secondary stream by reducing the gas stream velocity and allowing the liquids time to settle out with gravity assistance. To ensure complete liquid drop out the reservoir is sized to reduce the velocity to approximately 5% of the primary gas velocity. This reduction in velocity is only realized with conventional separation technology in a vessel 5X the diameter of the pipeline, expensive and not piggable.

The now dry secondary stream exits through the collection reservoir nozzle to the separator inlet nozzle. The secondary stream is combined with the primary

stream at the downstream slotted aperture. The secondary flow through the reservoir piping is maintained by the low-pressure venturi created by the primary flow at the downstream edge of the aperture. The liquids collected in the reservoir are periodically removed through the blow off piping to an above grade low pressure tank.

Pigging capability is easily achieved by installing isolation valving between the flow separator and the collection reservoir. These valves are sized for only 5% of the maximum pipeline gas flow rate and are typically only 1/6 of the NPS size that would be required to isolate the reservoir of a traditional drip or a conventional separator. Closing the valves interrupts the secondary flow and 100% of the gas stream travels through the center pipe of the flow separator. The pressure propelling the pig is not allowed to bypass and a pressure differential is not required. After the pig run is complete the isolation valves are opened for normal operation. The isolation valving can also be used to clean the reservoir off line.