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# Completing the Liquefaction Train by Using Two-Phase LNG Expanders

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**ABSTRACT**

The modern natural gas liquefaction process is based upon the first continuous process invented in 1895 to liquefy air. In three steps the process, compresses and cools and then expands the gas to a lower temperature. This triple step is then repeated until the gas condenses. The expansion stage of the process was originally achieved by passing the compressed gas through a Joule-Thomson valve which expanded and cooled the compressed gas.

The first significant improvement in the expansion step occurred when a gas expander was incorporated. The gas expander extracts energy and cools the gas more efficiently however; a Joule-Thomson valve is still needed for liquid expansion.

The second improvement occurred a decade ago when the Joule-Thomson valve was replaced by an LNG expander which removes additional energy from the stream. Liquid expanders expand the pressurized LNG to a lower pressure, but operate still above the saturation pressure, to avoid vapour formation inside the liquid expander. The remaining pressure reduction is achieved across a two-phase, liquid-vapour Joule-Thomson valve.

Consequently the next step in improvement is to replace the two-phase liquid-vapor Joule-Thomson valve with an expander that is designed for both liquid and vapor. This missing equipment is the two-phase expander.

The two-phase expander recovers most of the available energy from the LNG stream while further cooling the liquid. More importantly, the two-phase expander eliminates the need for Joule-Thomson valve in the liquefaction process. This paper presents the design and performance of two-phase LNG expanders.