Twister - a revolution in gas separation

In the past, separating water and condensates from natural gas has proven both costly and complex, requiring large facilities with high capital and operating expenses. Recently, however, Shell and its partners have developed Twister, a new process that has the potential to lower capital and operating expenditures in the range of 10 to 25%.

by David Page, Michael Lander and Sjors de Kruiff, STV

Twister technology allows for smaller and lighter facilities than other gas dewpointing alternatives. It uses no moving parts, and the need for glycol/methanol systems is eliminated. The simplicity of the design allows for unmanned (and possibly sub-sea) operation.

Successful field tests have already proven the viability of Twister for use in tropical areas that have moderate hydrocarbon and water dewpoint requirements. An extensive research and development programme is in place to further develop the technology for stringent gas conditioning requirements. The ultimate vision is that Twister will provide the separation technology for LPG, ethane, CO_2 and H_2S extraction as well as dust removal, industrial drying and air conditioning.

Twister's biggest capital expenditure savings are seen in green field developments where the entire facility can be optimised. For example, in a study performed for an offshore application in the tropics, Twister's reduced facilities resulted in a smaller overall platform compared to a TEG water-dewpointing scheme. The result: US$20 to 30 million Capex savings on a US$150 million project.

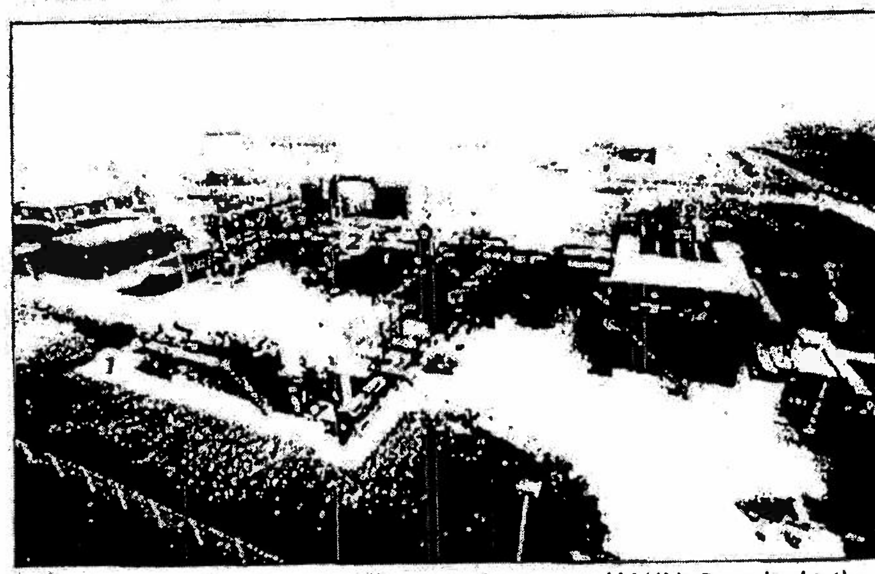

Figure 1: Smaller and environmentally sound: the Twister skid (1) in Barendrecht, the Netherlands, is more compact than its more traditional counterpart (2), Joule Thompson Valve and TEG injection.

Twister development and testing

Initial Twister development was conducted at Stork Product Engineering in Amsterdam using an air/water model operating at atmospheric pressures. An updated version of this facility remains in use to test ideas that may improve Twister performance while also allowing for the visualisation of flow phenomena.

Twister's first test using hydrocarbon gas was performed under laboratory conditions at the Gasunie test facility at Groningen in 1997. The unit successfully dried 0.7 million Nm^3/d at 40 bar, proving the principle behind the process and the potential for closed, emission-free gas treatment. Following this proof, a pilot Twister was installed in mid-1998 in a 5

Groningen gas cluster handling lean, but water-wet, gas. The inlet conditions were 110 bar and 40°C; mid-Twister conditions were 30 bar and -45°C; outlet conditions were 80 bar and 30°C.

The latest test unit was installed at Barendrecht, near Rotterdam in the Netherlands, in early 1999. The location, which produces a richer gas than Groningen, provides the opportunity to evaluate hydrocarbon separation performance. The unit was installed parallel to the existing JT valve and produced on-spec gas.

Further development testing is scheduled to commence in the fourth quarter of 1999 at Barendrecht as well as at a new test unit in Leermens, another Groningen cluster. The Leermens test skid will be handling lean Groningen gas. This testing will provide further development opportunities under field conditions, with results being aimed at water dewpointing in view of the

CFD modeling

In parallel with the experimental development programme, Stork Product Engineering - together with SIEP-NT, Shell Thornton and three Dutch universities - are developing analytical and numerical tools to describe the complex condensation phenomena and fluid dynamics inside Twister. These tools are aimed at providing inputs to a structured design and development process that involves testing in the air/water unit prior to demonstration of the technology in the field tests in Barendrecht and Leermens.

Dehydration and dewpointing performance

The actual performance required for dewpointing depends on the gas composition, inlet temperature, and pressure drop. In most cases, an entry temperature just above the hydrate temperature is achieved

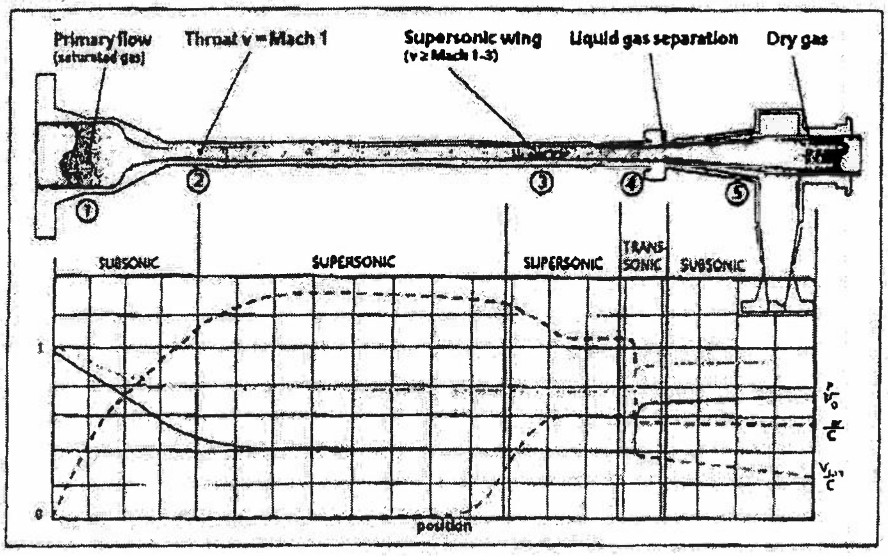

Figure 2: Compact and elegant, the Twister device provides for revolutionary supersonic gas solutions.

The principle behind Twister

Twister combines known physical processes in a unique way:

1) Gas is expanded adiabatically in a Laval nozzle, creating supersonic velocities and low temperatures (for example a temperature at inlet of 30°C drops mid-Twister to -50°C).
2) The low temperatures create a fog-like condensation, which is typically a mixture of water and heavier hydrocarbons. Hydrate formation will not occur because the limited residence time within Twister at these low temperature conditions will not allow for the relatively slow hydrate-crystal growth.
3) Still at supersonic velocities, the mixture of gas and liquid droplets enters the wing section, generating a high velocity swirl.
4) The resulting swirl forces the condensation outward to form a liquid film on the inner wall of the tube. The liquid film is then removed using either a co-axial tube or slits in the separation tube. The dry gas core remains as the primary stream.
5) After inducing a weak shock wave, 70 to 80% of the initial gas pressure is recovered using a diffuser.

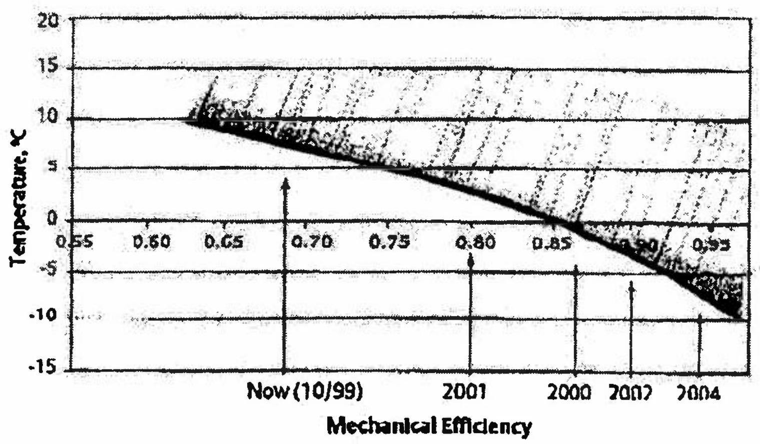

Figure 3: Twister's dewpoint in performance is expected to improve dramatically over

gas/gas heat exchanger. *Figure 3* illustrates Twister dewpointing performance in relation to mechanical efficiency (i.e. the percentage of mid-Twister condensed liquids that is removed from the primary gas stream).

Twister compared to conventional technologies

The twister team has completed several feasibility studies for a number of interested Shell Operating Units (OUs). In one of these studies, the application of Twister for onshore associated gas dewpointing was compared to conventional technologies. The study considered the differences in compression as well as total lifecycle cost. Comparative findings are shown in the table on the following page.

The future of the Twister organisation

At this time, the Twister venture team is part of the Shell Technology Ventures group inside SIEP. The plan is that within a few months, a Twister joint-venture company will be created in which several partners take a share. At this time, application of the Twister technology is being pursued with several Shell OUs. However, the mission of the Joint Venture will be to market the technology industry-wide.

Will Twister work for you?

If you would like to find out if a new technology like Twister would work for you,

1. Contact Twister at +31-70-3113990 and ask for *David Page* or *Michael Lander*.
2. Schedule a scoping discussion with a Twister representative, possibly including a visit to a demo unit.
3. Place an order for a feasibility study.
4. Receive a technical commercial proposal for a Twister application.