Where energies make tomorrow

# Swirl Flow Tubes

Boosting olefins production through enhanced heat transfer

T.EN TECHNIP ENERGIES


Another milestone achieved

# Ethylene and Furnace Technology

Technip Energies is a global player in the Ethylene market as technology licensor, designer, engineering contractor and supplier. Our global licensing market share since 2000 is about 50% of the world's total added capacity.

A key part of our portfolio is our cracking furnace technologies which contain a wide range of design options for reliable, flexible and highly selective solutions to meet stringent environmental regulations and the operational needs of our clients.

Technip Energies' Swirl Flow Tube (SFT®) technology can improve furnace performance by:

- Increasing run length and yearly availability
- Increasing furnace capacity

To understand how SFT works, it is important to first review a few basic heat transfer and steam cracking concepts.

**THE CRACKING PROCESS IN A NUTSHELL**

Cracking reactions are endothermic and driven by energy supplied to radiant coils from the combustion of fuel gas in the radiant box. The heat flows from hot flue gas in the firebox to the walls of the radiant coils by radiative and convective heat transfer and from the coil walls to the process gas by convection. The wall temperature is the result of a balance between the outside and inside heat transfer rates.

Due to the extreme conditions at which cracking takes place, some of the hydrocarbons get severely dehydrogenated and deposited as coke on the inside of the coil. Because coke is a poor heat conductor, this increases wall temperatures and coke formation.

Ethylene yields are favored by low pressure, high temperature and low residence time in the coil. The residence time can be reduced by shortening the length of the coils. However, this would lead to higher heat fluxes through the tube walls and hence, higher wall temperatures. This means that better and more expensive coil materials would be needed to achieve the same furnace capacity.

Moreover, higher wall temperatures would also result in more coke deposits. Therefore, technology that can improve heat transfer rates without raising tube wall temperatures would be a great advantage. Our SFT technology does precisely that.

# SFT Technology

SFT ensures the highest heat transfer increase at the lowest cost with respect to increased pressure drop.

The geometry induces a swirl and promotes circumferential mixing and convective heat transfer inside the coil (Figure 1).

The relative small increase in pressure drop compared to the heat transfer benefits makes the SFT tube the best application for increased performance of the ethylene furnace.

SFT is shaped by bending a straight tube so that the tube's centerline traces a helix in three-dimensional space. These tubes are characterized by small amplitudes and pitches of varying lengths as shown in Figure 2.

The maximum amplitude of the helix is less than the radius of the tube and provides a line of sight through the tube. The shape contributes to the optimization of the cracking process by changing the flow profile from 2D to 3D.

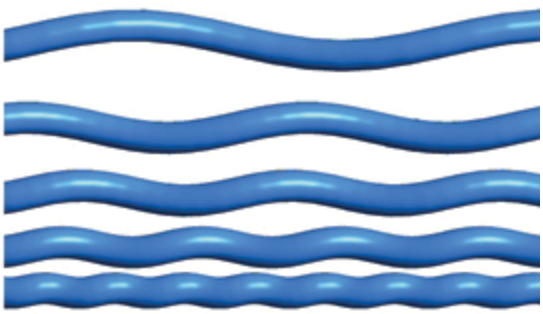


Figure 2: Examples of different small amplitude helical tubes: Swirl Flow Tubes

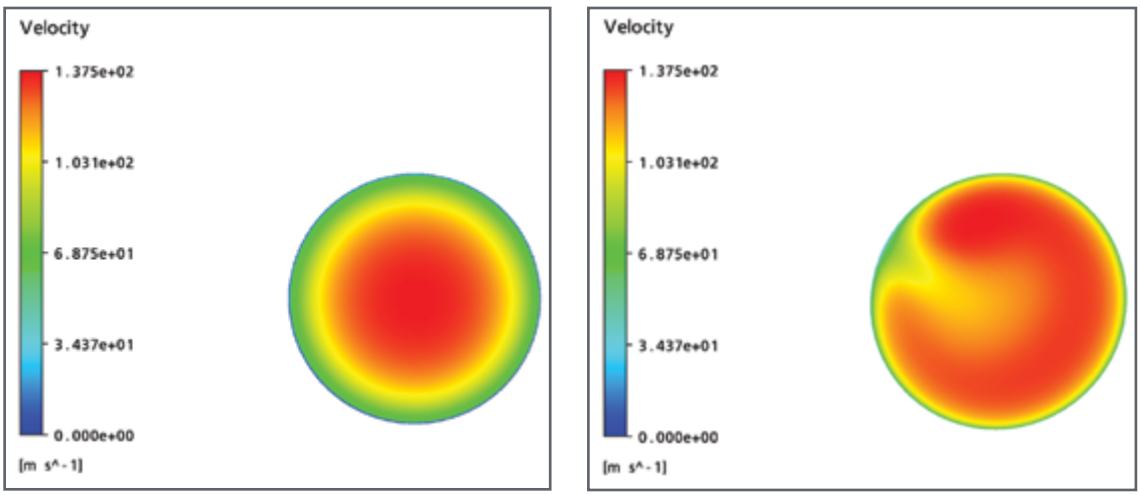


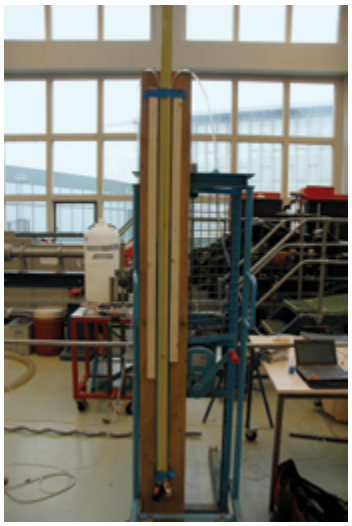

Figure 1: Velocity contours in straight tube and Swirl Flow Tube

# Validation of SFT technology

The fluid mechanics and heat transfer behavior of gases in SFT have been repeatedly tested experimentally and numerically in Computational Fluid Dynamics (CFD) analyses.

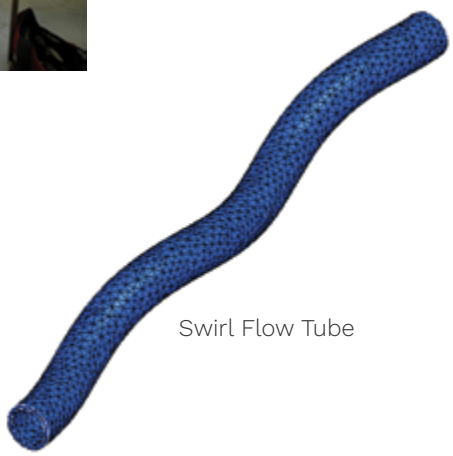
Technip Energies can now use the validated CFD model for all kinds of operating conditions. The mechanical behavior of SFT has been compared by means of Finite Element Method analysis with those of straight tubes at similar conditions to confirm that differences are within allowable limits.

The University of Ghent is recognized as one of the world's leading research and test facilities on steam cracking. It has a pilot cracking furnace capable of cracking hydrocarbons at conditions similar to an industrial plant. The university has developed special analysis equipment to accurately measure the cracked gas composition by means of a detailed hydrocarbon analysis. Several tests were performed in this furnace with SFT tubes to determine their coking behavior. The tests showed that the SFT geometry caused a substantial lowering in the coking rate due to the lower tube skin temperatures.

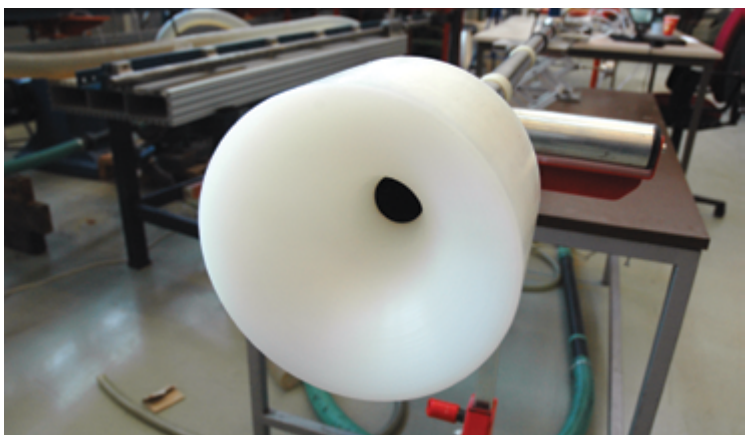


Water barometer

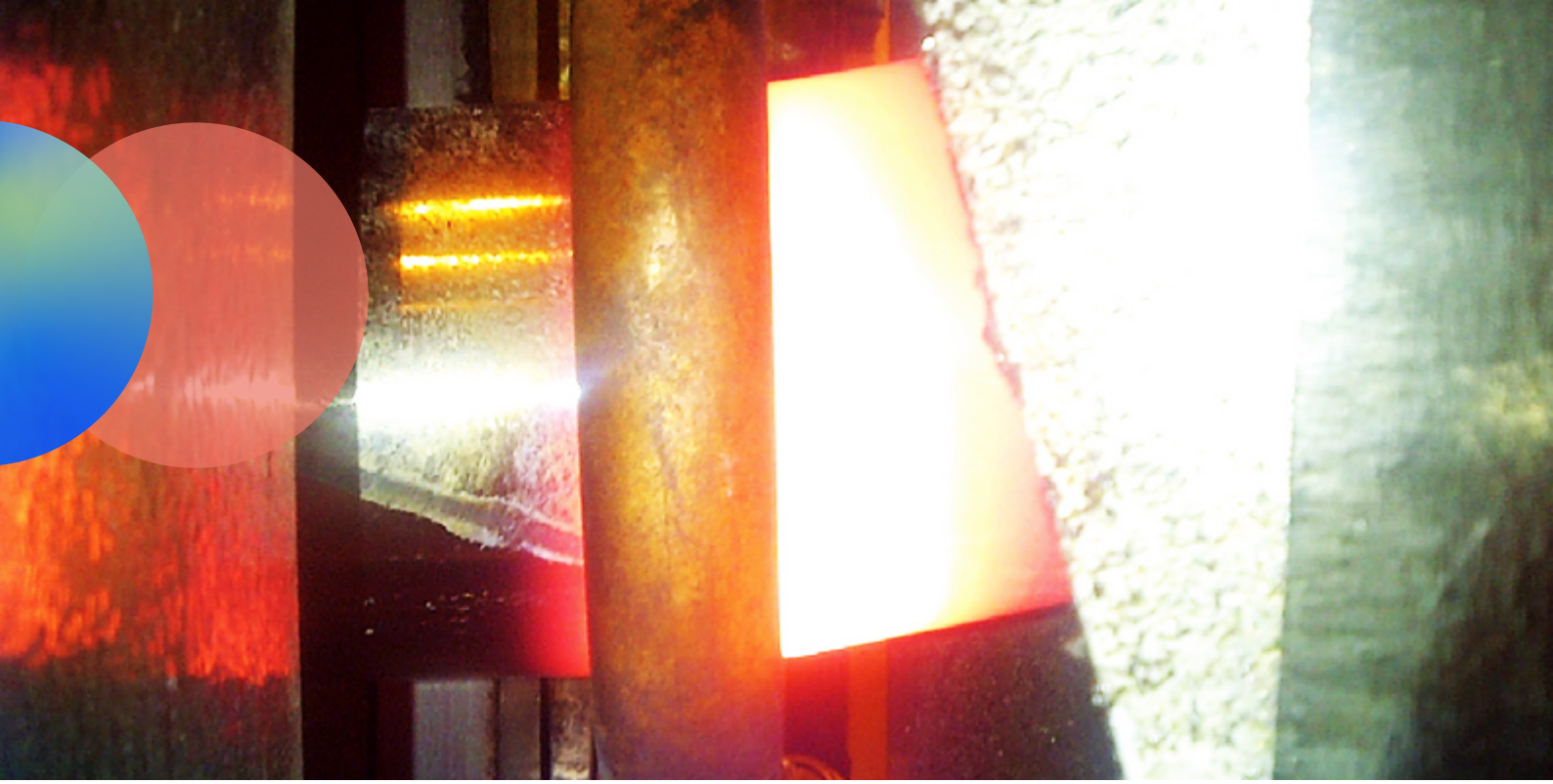
Pilot cracking furnace of the University of Ghent



Swirl Flow Tube



Pressure drop minimizing inlet nozzle



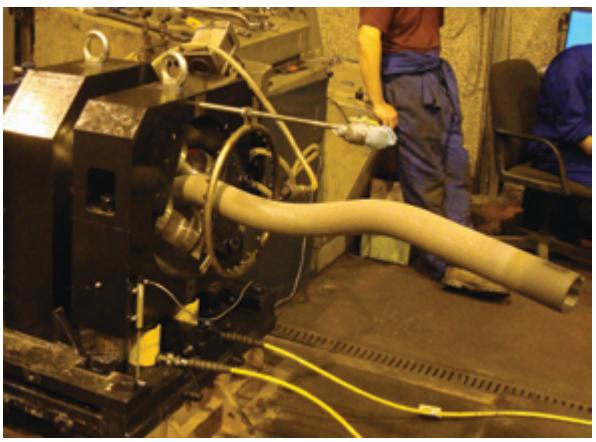
# Manufacturing SFT

Swirl Flow Tubes are produced by induction bending of straight tubes. Induction bending is an established process applied for more than 30 years on all kinds of tubes. Since the early 90's the process has been applied for the bending of cracking coils.

Technip Energies developed the equipment to transform a 2D induction bending machine into 3D. The latter is required to create the helical shape of the SFT tube.

This process can bend all types of radiant coils from all coil suppliers.

Maintaining SFT tubes is similar to maintaining straight tubes. Should a partial blockage in a tube occur, only a small part can be replaced, as can be done for a straight tube.

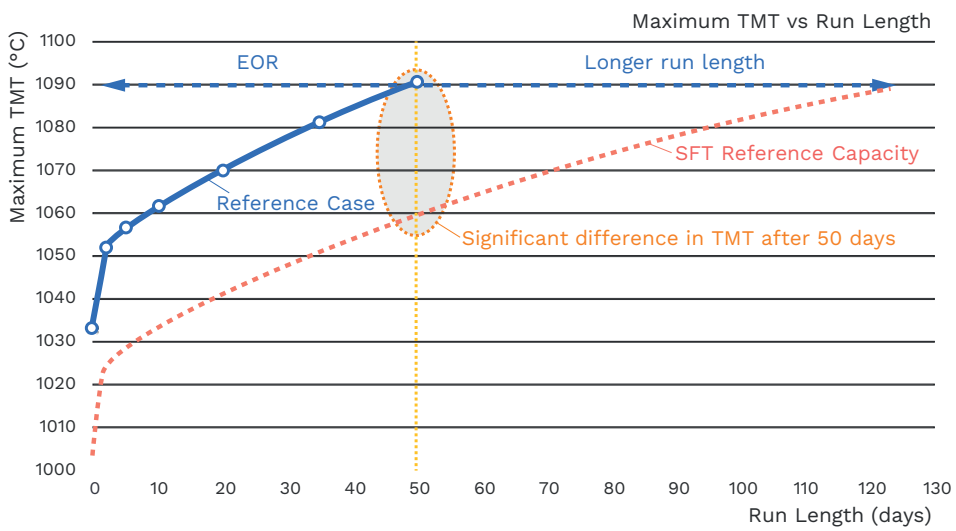


Swirl Flow Tubes are produced by induction bending of straight tubes.

# How SFT technology benefits ethylene plant operators

- Increases run length of a furnace – usually 20 to 50 days longer – at the same capacity
- Lowers NOx emissions
- Increases capacity, typically 10 to 30% at similar or same ethylene yield
- Allows increased selectivity by decreasing the residence time at the same capacity.
- Increases steam dilution ratio to enhance yields and reduce coke formation

The technology is best applied in tubes with the highest tube metal temperatures. It can be applied in existing furnaces of any supplier, and in grassroots furnaces.



**France**

Yvon Simon
+33 1 47 78 38 61
yvon.simon@technipenergies.com

**USA**

Ravi Lal
+1 909 447 3717
ravi.lal@technipenergies.com

**The Netherlands**

Zain Abdin
+31 79 3293 625
zainul.abdin@technipenergies.com

**UK**

Jim Middleton
+44 1908 20 3351
jim.middleton@technipenergies.com

**Italy**

Enzio Viviano
+39 06 65 98 35 65
enziosavio.viviano@technipenergies.com

Where energies makes tomorrow. **technipenergies.com**