



## **Radial Flow Ammonia Synthesis Converters**



## Introduction

The heart of any ammonia plant is the catalytic reactor in which the synthesis of ammonia from hydrogen and nitrogen takes place – the Ammonia Converter.

Topsøe pioneered radial flow type ammonia converters by installing the first radial flow converter in the 1960'ies. Since then a continuous program of developments has resulted in a comprehensive portfolio of radial flow converter designs to meet the multifaceted requirements in the industry, whether for new plants or for revamp of existing plants.

## Converter Types

Selection of the best converter type starts with the objectives of the client such as: Minimum investment, lowest energy consumption, maximum steam production, and possible reuse of an existing pressure shell. No matter what the specific needs are, Topsøe is always able to tailor a solution from one of the following types of ammonia converters:

**S-200** : Two catalyst beds and one interbed exchanger

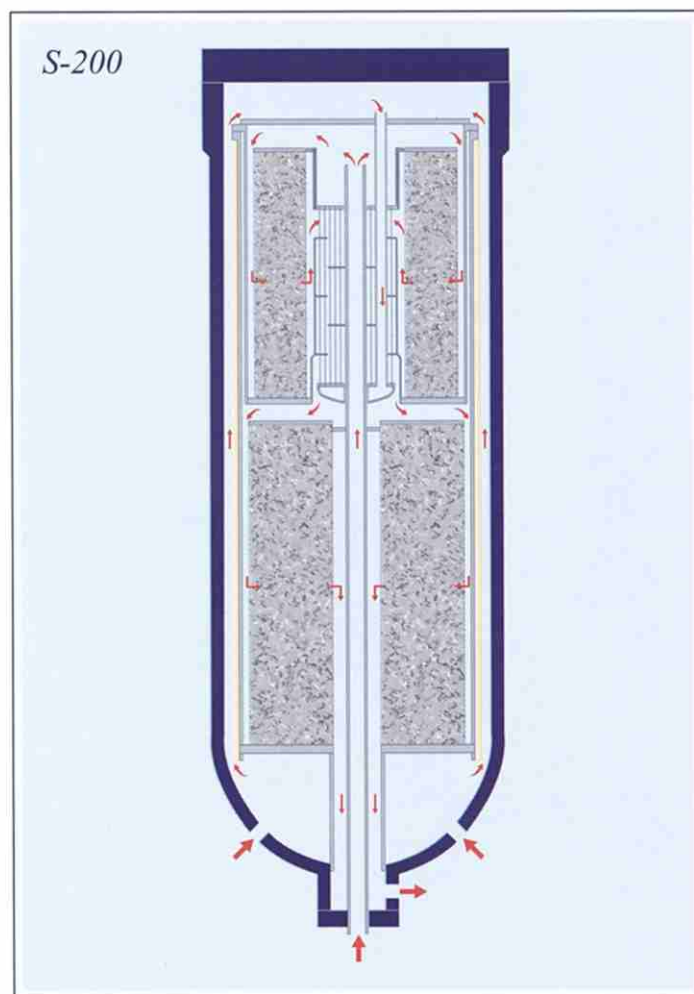
**S-300** : Three catalyst beds and two interbed heat exchangers

**S-50** : One catalyst bed

**S-250** : Combination of the S-200 converter followed by the S-50 converter

The above converter types are characterized by the following salient features:

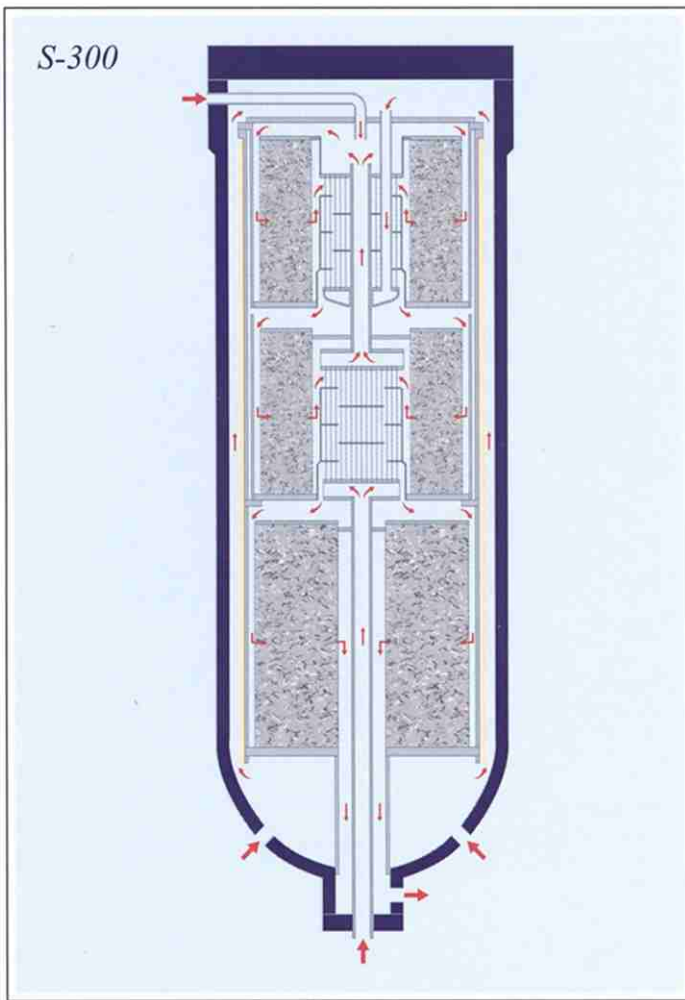
- 100% radial flow through the catalyst beds to obtain low pressure drop and high conversion with small size catalyst particles
- Indirect cooling of the gas in heat exchangers between the catalyst beds instead of quenching to avoid dilution of the converted gas
- Total converter feed flow passes through all beds, so the total installed catalyst volume is fully utilized
- Stable operation with great flexibility in operating range
- Simple temperature control



## S-200 Ammonia Converter

Ever since 1979, when the first S-200 converter was commissioned, it has been the reference point within the industry. At the threshold of the new millennium one hundred and thirty S-200 converters have been installed. More than two decades of operational experience combined with several mechanical enhancements still make the concept of two catalyst beds with a heat exchanger between the beds the most successful and versatile converter ever made.

Two versions of the S-200 converter are available: One with a built-in feed-effluent heat exchanger (lower heat exchanger) below the second catalyst bed for situations where the heat of reaction is utilised for preheating of boiler feed water downstream the ammonia converter. The other version shown on the drawing has no lower heat exchanger, because the outlet gas from the second bed goes directly to a boiler for production of high-pressure steam.



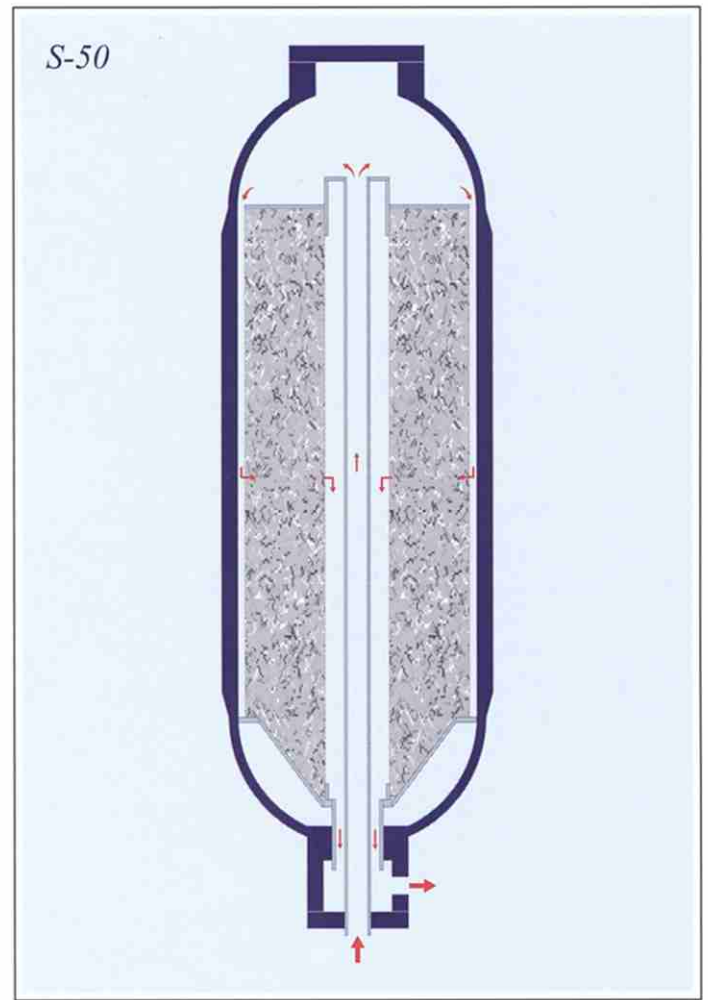
### S-300 Ammonia Converter

As a further development of the S-200 converter by adding a third catalyst bed and a second interbed heat exchanger, the S-300 converter enables a higher conversion for the same catalyst volume. This is of particular interest for revamp of ammonia converters, where installation of a new S-300 basket will lead to the shortest payback time. For new plants the S-300 converter requires a smaller catalyst volume, which translates into lower investment cost.

The first S-300 converter was installed in 1991 as retrofit of an axial flow quench converter.

### S-50 Ammonia Converter

Consisting of only one catalyst bed enclosed in flow distribution panels mounted directly on the inside wall of the pressure vessel, the S-50 converter is the simplest and cheapest of all Topsøe radial flow converters. Installation of an S-50 converter downstream an existing ammonia

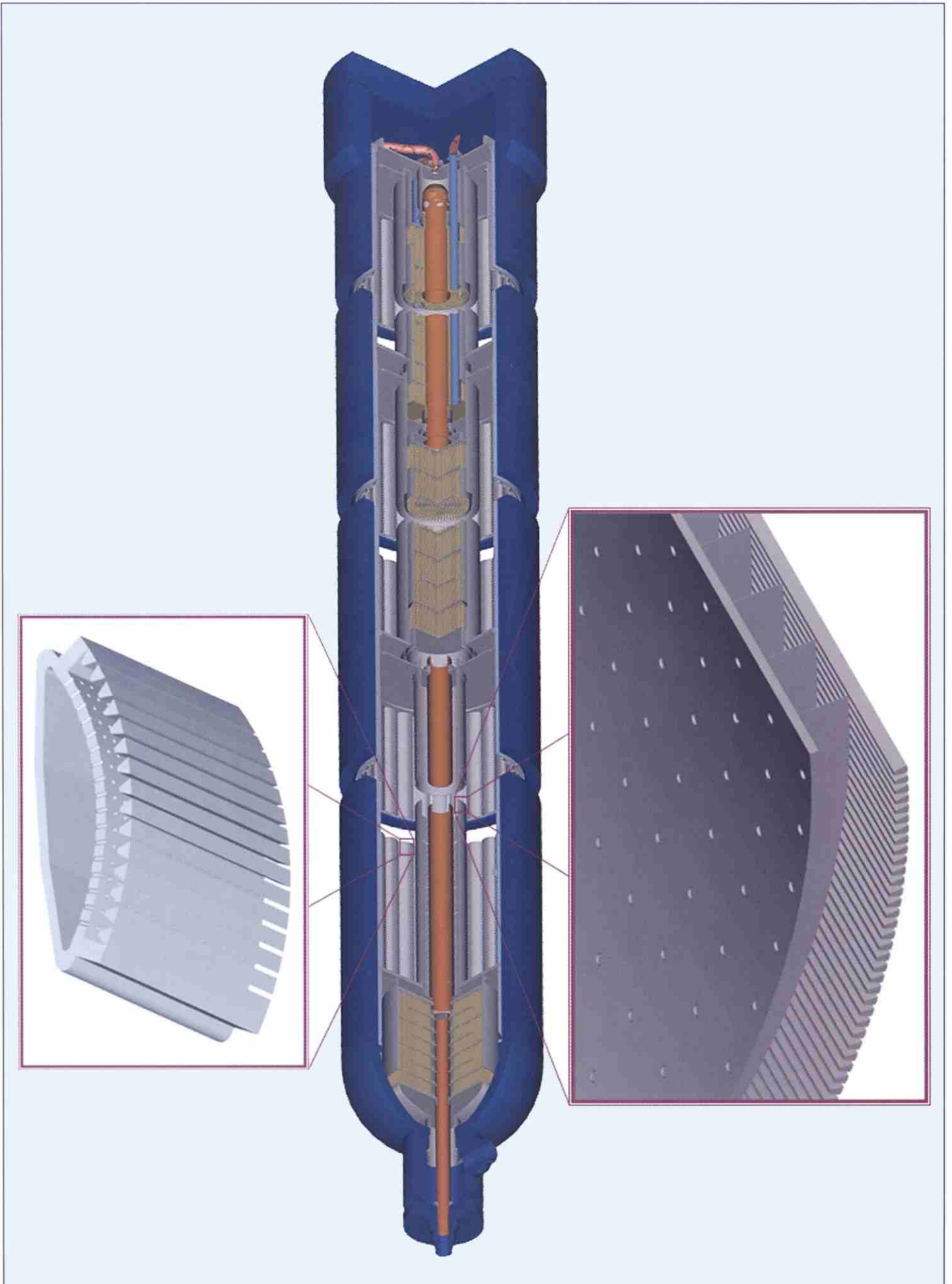


converter is an attractive way of boosting the capacity of old ammonia plants by 25% or more.

The S-50 converter is also available in a version where the internals are built as a catalyst basket, which is installed in the pressure shell at the site. Shell cooling gas is provided between the pressure shell and basket to keep the pressure shell cold. Both versions have been in successful operation for several years.

### S-250 Ammonia Converter System

The S-250 converter system consists of an S-200 converter followed by an S-50 converter. Heat recovery in terms of high-pressure steam production or steam superheating takes place between the two converters. This converter configuration enables the highest production capacity in a single train and gives the lowest energy consumption. That is why the S-250 converter system has been chosen for the most energy efficient ammonia plants in the world.



*Topsøe S-300 Ammonia Converter*

## Mechanical Features

All Topsøe radial flow converters are built to withstand the severe operating conditions for ammonia synthesis, i.e. elevated temperature and pressure combined with high contents of hydrogen and ammonia, which requires special considerations in the mechanical design and choice of construction materials.

As an exclusive feature, the Topsøe design uses a gas distribution system around the catalyst beds consisting of a number of screen panels placed side by side along the outer peripheries of the beds and cylindrical screens in the centre of the beds. In this way it has been possible to completely eliminate the use of wire mesh, known to be the cause of mechanical failures in other designs.

The gas distribution system has a smooth surface towards the catalyst, which minimizes the friction between the catalyst and the internals during thermal expansion and contraction in connection with start-up and shut-down.

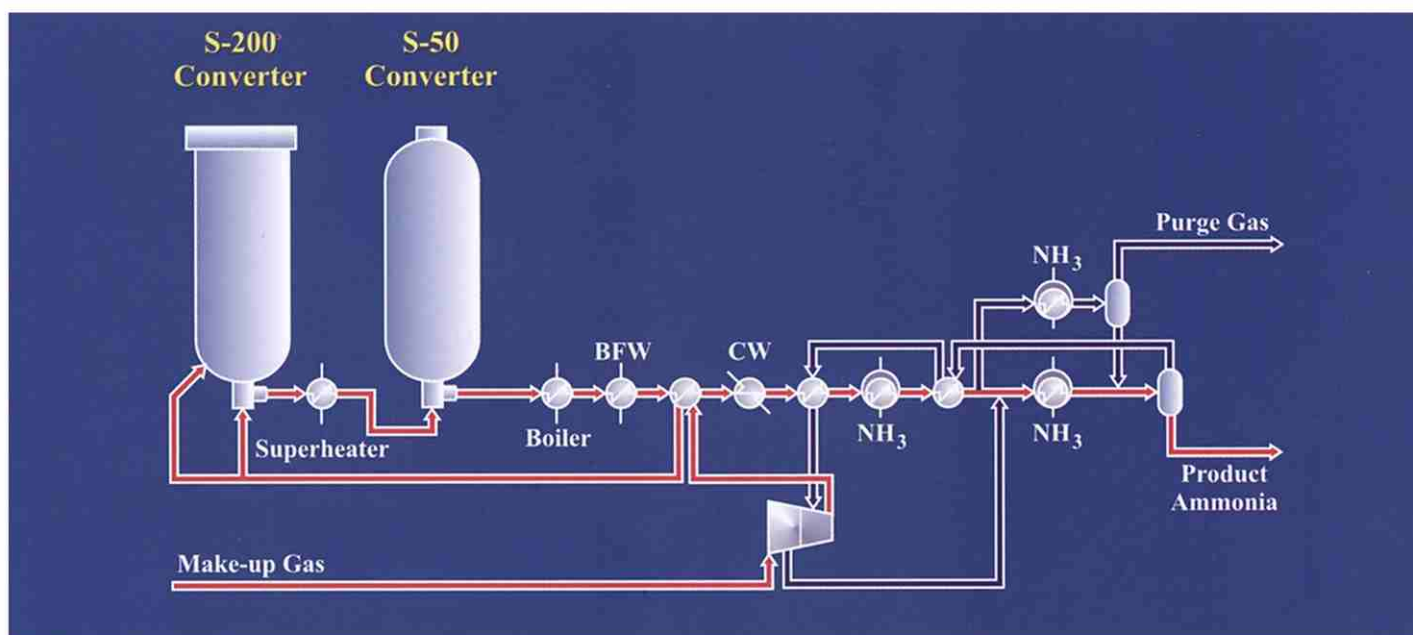
Furthermore, the screen panels and centre screens are equipped with perforated liners to ensure an optimal flow distribution.

## Why Choose a Topsøe Ammonia Converter Solution

Topsøe has been a partner to the ammonia industry for more than half a century. The position as the world's largest supplier of ammonia synthesis catalyst and licensor for 50% of the ammonia plants built within the last two decades is the result of our commitment and knowledge within the field of ammonia production. No other company integrates the knowledge from R&D with feedback from our customers as we do – all with the purpose of offering the best plant performance and the lowest production cost.

When buying a converter solution from Topsøe, whether it is for an existing plant or a new plant, our organization supports you from the project start to production of ammonia in the new ammonia converter. But even more importantly, our organization is available to help you when the plant is in operation. You can count on Topsøe to provide single point responsibility including the following services:

- Supervision during installation, catalyst loading, catalyst reduction, and start-up
- Technical support for optimization and troubleshooting
- Catalyst performance evaluation on regular basis



*Topsøe S-250 Ammonia Synthesis Loop*

# Haldor Topsøe A/S:

Research & Development • Licensing & Engineering  
Catalyst Manufacture • Equipment Manufacture



Founded in 1940 by Dr. Haldor Topsøe as a research-based organization for development of chemical processes and catalysts, Haldor Topsøe A/S has a prominent international record in heterogeneous catalysis and catalytic processes.

The Topsøe Group, formed by Haldor Topsøe A/S and its subsidiary companies, has a permanent staff of about 1,500. The Group's Headquarters and central research laboratories are located north of Copenhagen, while production takes place at Frederikssund, Denmark and Houston, Texas, U.S.A.

The development, production and engineering associated with catalysts and catalytic processes have taken the Haldor Topsøe A/S organization into many different areas of technology. An outstanding level of fundamental and applied research is maintained in extensive research laboratories, in pilot units and large-scale demonstration units.

The main activities are in chemical industries, and more specifically in the production of fertilizers, other chemicals and petrochemicals, oil refining, gas conversion and related technologies, energy and environment.

Through a vast network of contacts to research institutes, organizations and industrial partners all over the world, the Topsøe Group contributes to the advancement of catalysis - a challenging and important field at the crossroads of physics and chemistry.

## DENMARK

HALDOR TOPSØE A/S  
P.O. Box 213  
Nymøllevej 55  
DK-2800 Lyngby  
Phone: +45-45 27 20 00  
Telefax: +45-45 27 29 99

## INDIA

HALDOR TOPSØE  
INTERNATIONAL A/S  
India Liaison Office  
Apt. A-5, Qutab Hotel,  
Off Sri Aurobindo Marg,  
New Delhi 110016  
Phone: +91-11-686 4735  
Telefax: +91-11-686 2252

## JAPAN

HALDOR TOPSØE  
INTERNATIONAL A/S  
Tokyo Branch Office  
Kioicho Building, 14th Floor  
3-12, Kioi-cho  
Chiyoda-ku, Tokyo 102-0094  
Phone: +81-3-5210 2751  
Telefax: +81-3-5210 2754

## PEOPLE'S REPUBLIC OF CHINA

HALDOR TOPSØE  
INTERNATIONAL A/S  
Beijing Representative Office  
Room 1008, Scitech Tower  
22 Jianguomenwai Dajie  
100004 Beijing  
Phone: +86-10-6512 3620  
Telefax: +86-10-6512 7381

## RUSSIA

HALDOR TOPSØE A/S  
Moscow Representative Office  
Bryusov Street 11, 4th Floor  
103009 Moscow  
Phone: +7-095-229-6350  
+7-503-956-3274  
Telefax: +7-503-956-3275  
ZAO HALDOR TOPSØE  
42 Respublikanskaya  
150040 Yaroslavl  
Phone: +7-0852-252558/259696  
Telefax: +7-0852-252558

## USA

HALDOR TOPSOE, INC.  
17629, El Camino Real  
Houston, TX 77058  
Phone: +1-281-228-5000  
Telefax: +1-281-228-5019  
HALDOR TOPSOE, INC.  
Refining Technology Division  
770 The City Drive  
Orange, CA 92868  
Phone: +1-714-621-3800  
Telefax: +1-714-748-4188

[www.topsoe.dk](http://www.topsoe.dk)