Value drivers for conversion to ODC Technology

Conversion to ODC is conditioned by a series of economic and environmental factors that are site specific and should be balanced with the energy and CO_2 emissions savings achieved with ODC Technology. As economic factors, infrastructure investments, oxygen supply and hydrogen demand should be considered.

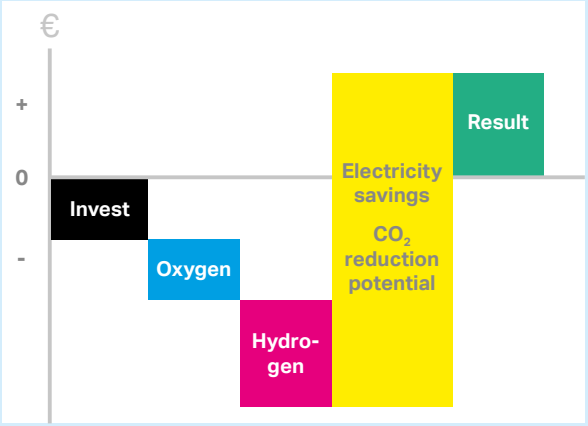

Fig 5. Economic and environmental drivers to be considered in the conversion to ODC Technology.

Research milestones & market launch

1992 Research work on ODC technology started @ Covestro.

2006 The project "CO_2 reduction during the production of basic chemicals" was brought successfully in the "klimazwei" programm. Under BMBF finanzing and the lead of Covestro, a consortium of 12 partners worked on the optimization of the design of cells, ODC performance and reduction of ODC production costs.

2011 First big scale production plant (chlorine capacity: 20,000 tons / year came on stream).

2013 Two years of safe and reliable operation, market launch together with ThyssenKrupp Uhde Chlorine Engineers.

2015 Construction of ODC automatization plant.

Fig 6. ODC demonstration plant in Krefeld-Uerdingen.

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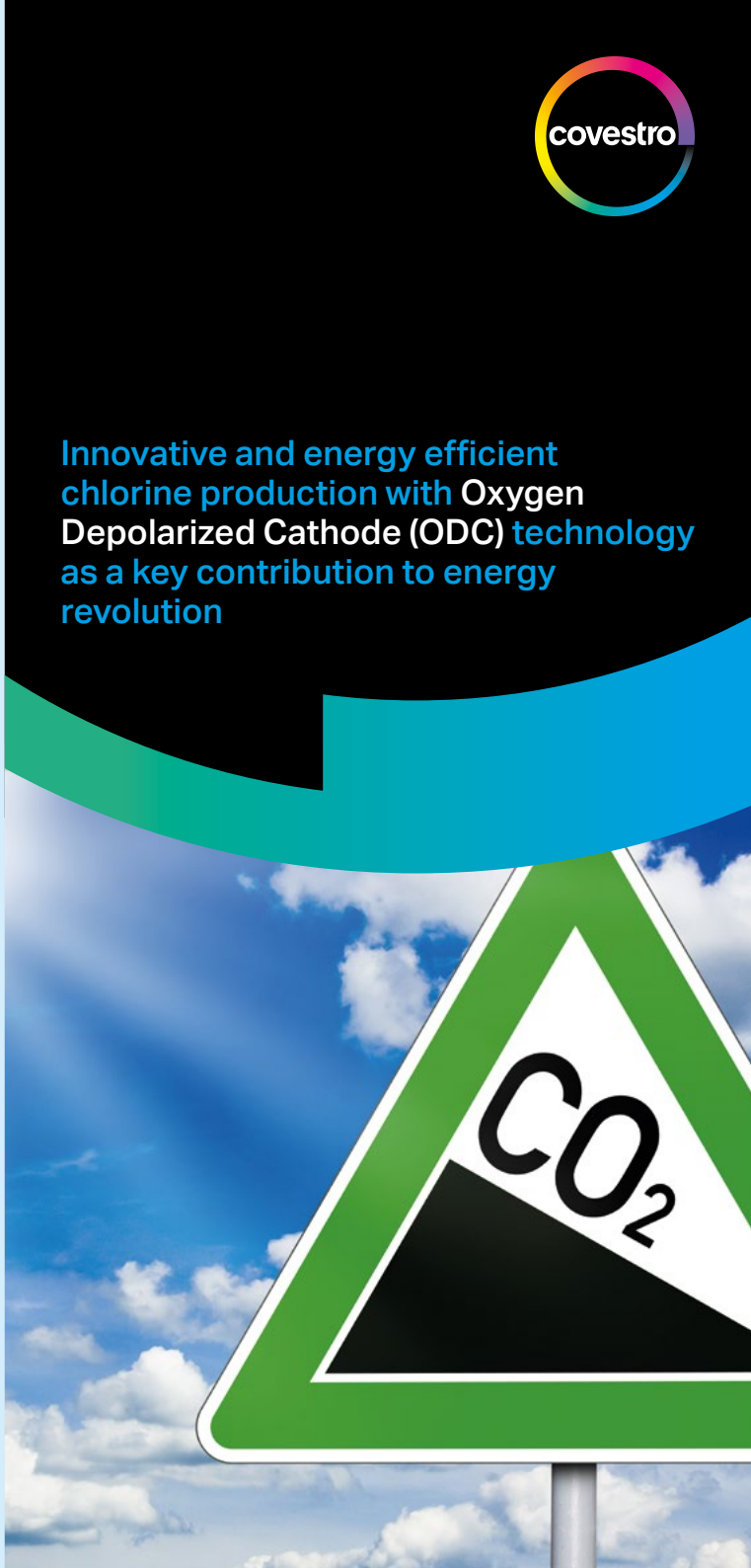
As of: April 2017

Innovative and energy efficient chlorine production with Oxygen Depolarized Cathode (ODC) technology as a key contribution to energy revolution



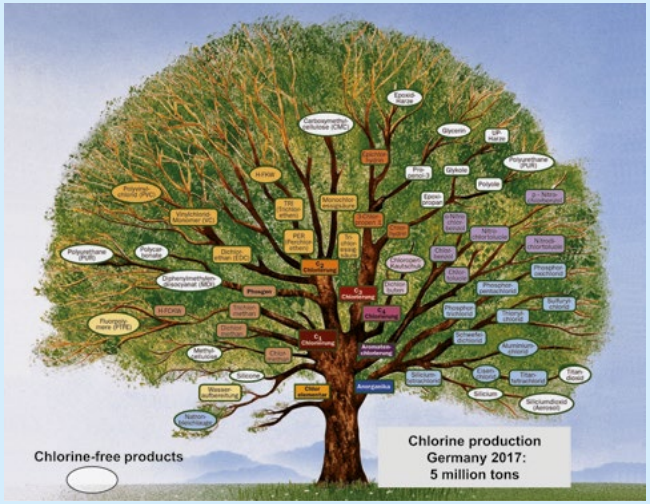


Fig 1. The Chlorine tree.

The importance of chlorine as a basic chemical

Chlorine is an essential basic chemical for the chemical industry, as well as its associated product caustic soda. About 60 % of all chemical products are produced, directly or indirectly, using chlorine and / or caustic soda. They both are obtained on an industrial scale by the electrolysis of common salt (chlor-alkali).

Worldwide demand of chlorine has increased around 60 % over the last 20 years. The current annual capacity of chlorine worldwide accounts to about 89 M tons, 5 M tons in Germany. Chlor-alkali electrolysis requires about 2,500 kWh of electrical energy per ton of chlorine produced (membrane technology).

Chlorine is used in a wide range of processes to create thousands of indispensable products, applicable in pharmaceuticals, medical devices, windows, flooring and insulation, photovoltaic cells, etc.

Innovative ODC Technology shakes up energy intensive Chlorine production

Common salt electrolysis can be performed through diaphragm and membrane technology. The last revolutionary development has been electrolysis using Oxygen Depolarized Cathode (ODC), which enables a reduction of the electrical energy demand and CO_2 emissions of up to 30 %.

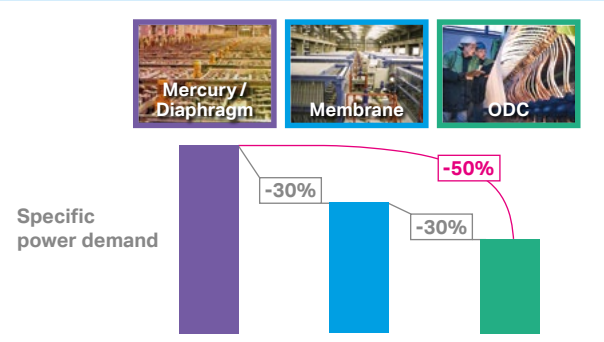


Fig 2. Technologies for chlorine production.

Potential environmental impact

Implementation of ODC as standard technology for chlorine production in Germany (capacity 5 million Cl_2 ton / year) would mean an energy saving potential of:

- 1 % of its national energy consumption / year.
- Total energy consumption of a city like Cologne / year.
- About 2,5 million tons $C0_2$ / year.
- A reduction in emissions of about 700,000 cars / year or a driving performance of around 10 billion km / year.

ODC Technology in a nutshell

ODCs are highly complex laminar structures constituted by materials such as catalysts, carrier materials, PTFE components and additives. They are built up by Covestro in a specific way and scaled up, along with a particular manufacturing method.

Development of the electrolysis cell is also an important part of the overall plan, which has been performed by ThyssenKrupp Uhde Chlorine Engineers.

Fig 3. ODC production @ Covestro Deutschland AG.

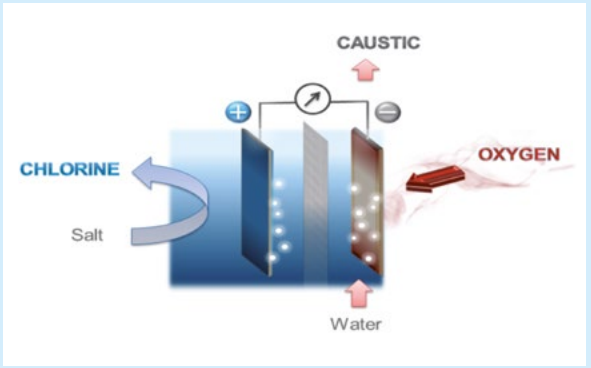


Fig 4. Common salt – ODC Electrolysis cell.