Increasing the capacity of chemical plants with oxygen enrichment

For bulk production of chemicals based on homogeneous gas/liquid oxidation technologies molecular oxygen from process air is a widely applied oxidant. Frequently through application of additional oxygen a moderate enhancement of O_2-content (range: 24 – 27 vol.-%) in the oxidation air suffices to considerably enhance oxidation reactor performance.

Effects and benefits

- Increase in throughput
- Increase in conversion
- Support of air compression
- Relief of waste gas treatment

In many cases the achievable effects allow debottlenecking of existing production plants requiring only minor capital investment.

Applications

Potential applications of O_2-enrichment in air oxidation reactions are:

- Terephthalic acid (PTA) and its dimethyl ester (DMT) from p-xylene
- Oxidation of cyclohexane for production of caprolactam and adipic acid
- Benzoic acid from toluene
- Acetaldehyde from ethylene
- Oxidation of anthraquinones for production of H_2O_2

Experiments

O_2-enrichment is usually not implemented until experiments have been made to reliably predict the effects to be expected in the production plant.
For experimental investigation of homogeneous gas/liquid reactions Linde has erected a **test plant based on a stirred reactor system**.

Example

In this mobile plant test-runs have been performed to prove the feasibility of O_2-enrichment in air-oxidation of e.g. cumene. The main product of this autoxidation is cumene-hydroperoxide, an intermediate in industrial production of phenol and acetone.

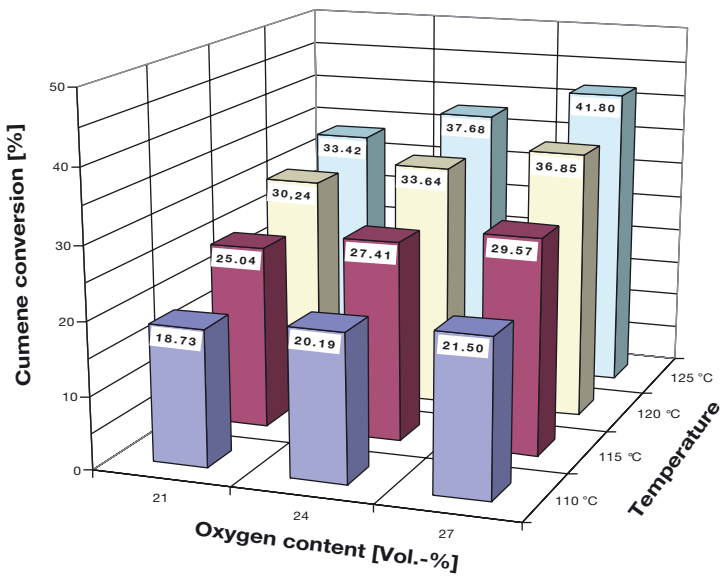

Fig. 1:
Conversion of cumene as a function of temperature and O_2-content of the applied oxidation gas

Oxygen supply

O_2-enrichment is often accomplished by injection of gaseous oxygen into the pressurized air line. Depending on the required quantity and the surrounding infrastructure, oxygen may be supplied from a pipeline, an on-site plant or from a tank containing liquid oxygen. Supply from a tank is recommended for small and especially for fluctuating O_2-demand. For steady requirements and O_2-flows exceeding approximately 300 Nm^3/h it is often more economical to use, for example, a dedicated pressure swing adsorption plant. Such a supply system provides oxygen with a sufficing purity in the lower 90 percent range.

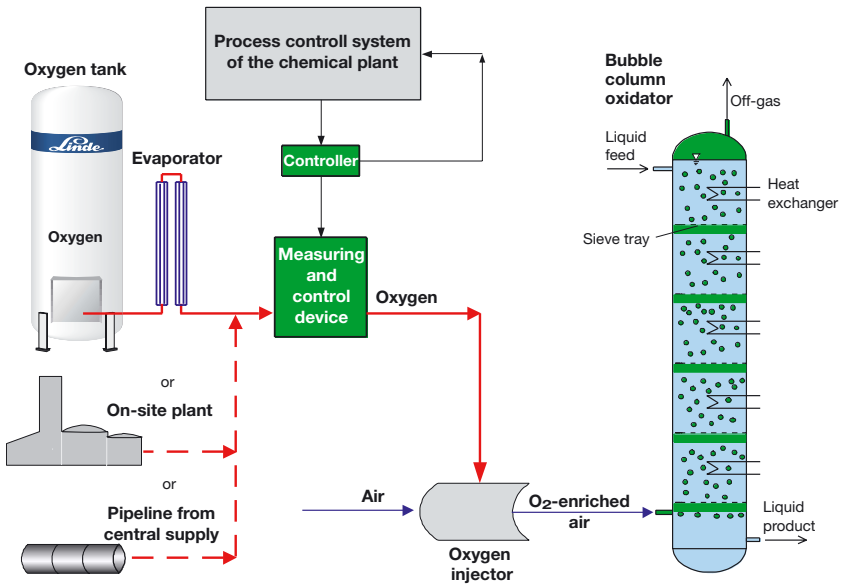

Fig. 2:
Basic diagram showing the implementation of O_2-enrichment in a chemical plant using air oxidation in the homogeneous gas/liquid-phase

Range of services

For O_2-enrichment in industrial oxidation processes Linde provides services to help evaluate feasibility and to implement the system:

- Experimental studies on O_2-enrichment, e.g. using Linde's stirred reactor test plant in the case of homogeneous oxidations in the gas/liquid-phase
- Calculations to scale-up experimental results, e.g. to a bubble column oxidation reactor or to a stirred oxidation vessel
- Selection of a suitable industrial solution
- Assistance in the evaluation of safety aspects
- Selection of the most economical oxygen supply system
- Delivery and installation of oxygen supply equipment including systems for O_2-injection, measurement and control start-up assistance
- Reliable oxygen delivery

Printed information on all Linde products and services, including the "Mobile Test Plant for Gas/Liquid Reactions", is available from our sales offices.

Please contact our specialist staff for further information.

Linde AG
Linde Gas Division
Seitnerstraße 70
D-82049 Höllriegelskreuth
Phone: +49 89 7446-0
Fax +49 89 7446-1230
www.lindegas.com