MATERIAL SELECTION CRITERIA
STAMICARBON CO_2 STRIPPING
UREA PROCESS

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All technical and other information contained herein is based on general Stamicarbon/DSM experience and within this limit is accurate to the best of our knowledge. However, no liability is accepted therefore and no warranty or guarantee is to be inferred.

1. General

Knowledge of corrosion phenoma and know-how on corrosion prevention is essential in the industrial production of urea from carbon-dioxide and ammonia, where carbamate corrosion possibly occurs. This carbamate corrosion is depending on the oxidizing character of the process fluid.

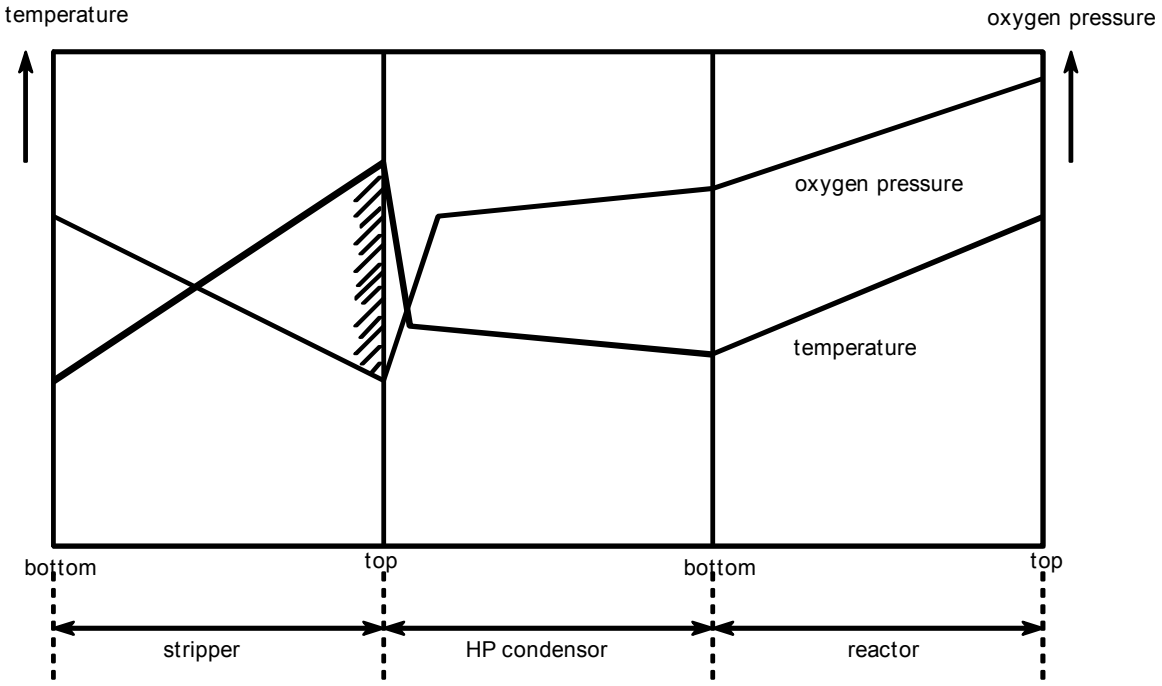
The large scale operation application in the production of urea became possible only when it was discovered that the corrosion of these steels in urea media can be reduced to a negligible level by addition of oxygen. Corrosion prevention in the Stamicarbon CO_2 stripping process is achieved through a well-considered combination of oxygen content, technological features and stainless steel types.
This is supported by:

- the material and corrosion research department of DSM, the mother company;
- testing in DSM's urea plant and the experiences in the urea plants in operation according Stamicarbon technology;
- through regular plant inspections and after sales services;
- the guidance of material and equipment manufacturer's through exchange of know-how;
- material and equipment inspections;
- survey the TQM.

At any given point in urea plant the corrosiveness is determined by the temperature, the process mixture components - ammonia, carbon dioxide, urea, and water - the concentration of dissolved oxygen and the possible presence of contaminants that may have an effect on the corrosion process. The oxygen, either pure or in form of air, is usually added to the carbon dioxide, as this is the simplest method. Care has to be taken, however, that even under the most hazardous conditions the amount of oxygen should still be sufficient.

Figure 1 gives an idea of the conditions in a urea stripping plant. It indicates that the oxygen partial pressure in a stripping unit is lowest in the stripper top, and that the temperature is highest there. In order to minimize the risk of corrosion in critical areas like this, material of higher corrosion resistance than the commonly used 316L must be applied.
Extensive laboratory research done with a view to optimizing corrosion resistance, mechanical qualities and weldability, has resulted in the selection of the stainless steel X2CrNiMoN 25-22-2 as construction material for high hazard regions.

Figure 1: Temperature and oxygen pressure level in the synthesis section.



Selection Criteria

Taking into account the afore mentioned, materials are selected to avoid excessive corrosion, to obtain optimal safe conditions, to have a most economical material choice, and to make manufacturing, repairing and maintenance of equipment possible.

The material selection shall be according the following criteria:

- Passivation during start-up by means of low pressure start-up method

- Passivation during operation by means of addition of min. 0.6% O_2 by volume in the carbon dioxide feed to the stripper

- Blocking-in period of the synthesis section of 72 hours

- Selection of optimum N/C ratio in the reactor in order to maintain low temperatures in the stripper

- Application of normal stainless steels which are weldable and maintenance friendly

- A lifetime of minimal 20 years for the equipment:
  * Corrosion rate of average 0.06 mm per year in the stripper tubes
  * Corrosion rate of 0.05 to 0.1 mm per year in the urea reactor
  * Negligible corrosion rate in the other high pressure equipment
  * Corrosion allowance of 2 mm (one-sided) on stainless steel liners and internals of high pressure equipment

    * Minimum thickness of 8 mm for stainless overlay welds in high-pressure equipment. Strip overlay welding in at least 2 layers, manual overlay welding in at least 3 layers. Minimum 3 mm shall meet the material specification requirements of Stamicarbon.

- Material shall meet the material specification of Stamicarbon and the pertaining general specifications

- For the low-pressure and vacuum equipment normal stainless steel are selected. No corrosion allowance is given as process conditions for this equipment is such that the corrosion rates are negligible

- Corrosion rates for the carbon steels as per contractor's project specification

- Crevice free design at process side of the high pressure equipment in order to avoid crevice corrosion due to oxygen displetion

For actual achieved life-times of high-pressure equipment we refer to the references as given in Attachment I.

Attachment I: List with present service life of equipment [1)]

Urea reactors

Contract	Client	Years of operational life
1968	DSM, Netherlands	25 years
1968	HFC, Israel	24 years
1967	SNA, France	25 years
1966	Azolacq, France	26 years
1968	Triad, USA	24 years
1967	PIC, Myanmar	25 years
1971	Iffco, Kalol India	21 years
1973	MCF, India	19 years
1973	CFL, Canada	19 years
1973	Igsas, Turkey	19 years

*CO2 Strippers**

1971	Iffco, Kalol	21 years
1975	Semadco, Egypt	16 years
1974	Abu Qir, Egypt	16 years
1973	MCF, Mangalore	19 years
1973	Igsas, Turkey	19 years
1973	CFL, Canada	19 years
1975	Fertimex, Mexico	17 years
1975	TFC, Taiwan	18 years
1975	CNC, USA	18 years
1975	Qafco, Qatar	17 years

High Pressure Carbamate Condensers

Contract	Client	Years of operational life
1967	SNA, France	25 years
1966	Azolacq, France	26 years
1968	HFC, Israel	24 years
1974	Abu Qir, Egypt	16 years
1976	Ultrafertil, Brazil	15 years
1975	Ferquimex, Mexico	16 years
1975	TFC, Taiwan	17 years
1973	Igsas, Turkey	19 years
1975	Qafco, Qatar	17 years
1968	Triad, USA (replaced 1994)	23 years

High Pressure Scrubbers

1968	DSM	25 years
1967	SNA, France	25 years
1968	Azolacq, France	26 years
1968	Triad, USA	24 years
1974	Abu Qir, Egypt	16 years
1976	Ultrafertil, Brazil	15 years
1968	HFC, Israel	24 years
1975	Ferquimex, Mexico	16 years
1975	Qafco	17 years
1973	MCF, India	19 years

* The CO_2 strippers of Stamicarbon's earlier plants were manufactured from 316L which proved to be not corrosion resistant enough for the process. All the 316L strippers were replaced by 25-22-2 strippers

1) The equipment mentioned in this list is at the time of investigation (mid 1995) still in operation at the various locations.