Consultation: Valves for CO_2

In gaseous, liquid and super critical CO_2

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Table of contents

1. About the Porthos project

The Netherlands has set itself clear climate targets: by 2030, Their objective is to reduced its greenhouse emissions by 49% compared to 1990 levels, and 95% by 2050. One measure that Dutch industry can take to achieve these climate objectives is Carbon Capture Usage and Storage (or CCUS for short). In CCUS, CO_2 is captured at the source and reused or stored underground. The important role played by CCUS in the energy transition is confirmed both in the Rutte III Cabinet's coalition agreement and the main outlines of the upcoming European Climate Agreement.

That's why the Port of Rotterdam, Gasunie and EBN are jointly preparing a new project in which CO_2 generated by industry in Rotterdam's port area is captured, transported and stored in empty gas fields deep in the North Sea seabed. A small volume of CO_2 can also be used in the greenhouses of Zuid-Holland to increase crop growth. The three companies have joined strengths under the project banner Porthos: Port of Rotterdam CO_2 Transport Hub & Offshore Storage.

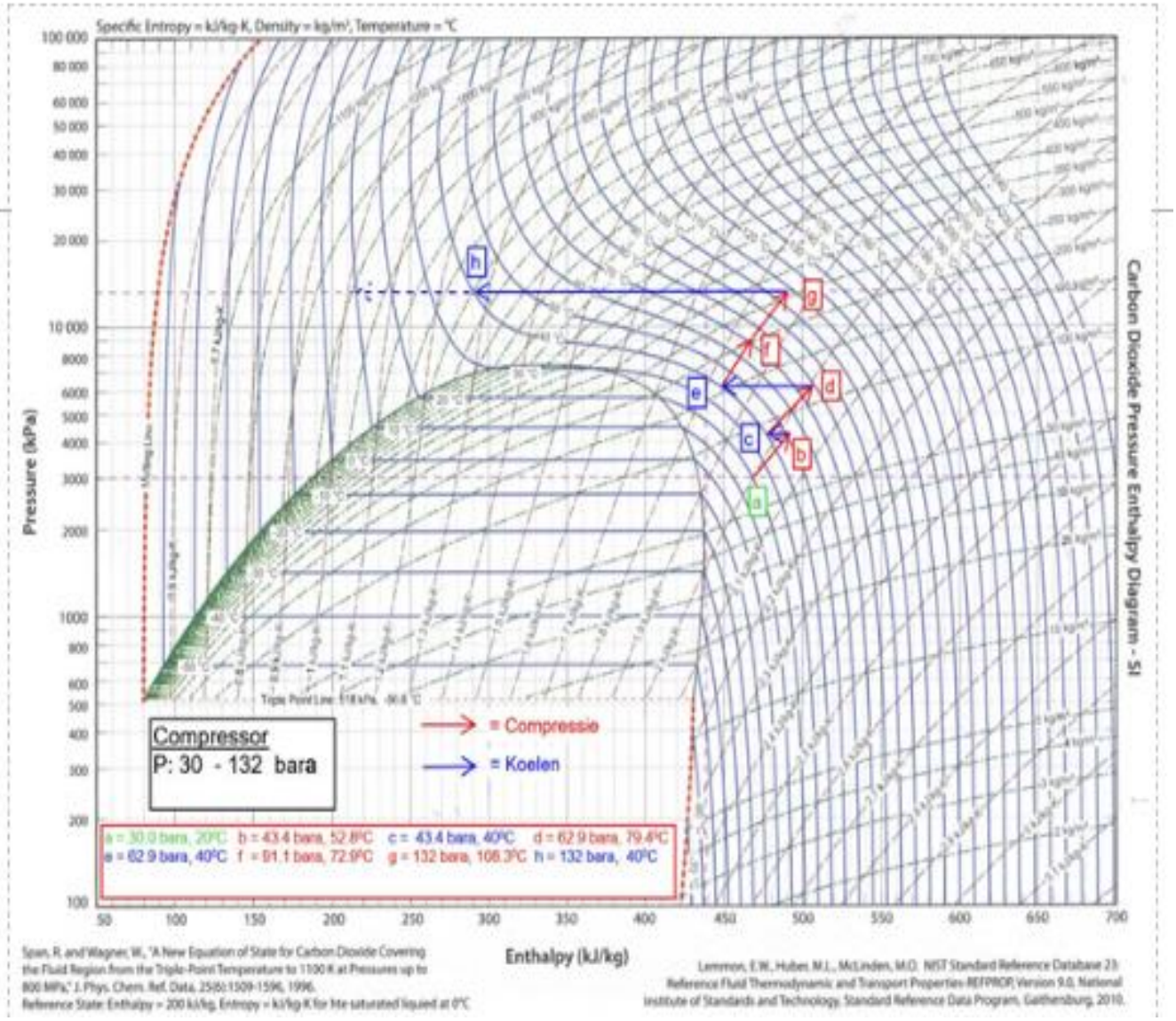
The three public shareholdings Port of Rotterdam, Gasunie and EBN all play an important role in the Dutch energy landscape. Besides helping to reduce the Netherlands' CO_2 emissions, these organisations also aim to play an active role in the energy transition.

The three will be working together in this CCUS project, with each party contributing its specific experience and expertise. The Port of Rotterdam Authority will be focusing on the local situation and market, EBN will be sharing its expertise in the area of the Dutch subsurface and offshore infrastructure and Gasunie can offer extensive experience with gas infrastructure development and gas transport.

Porthos is the abbreviation for Port of Rotterdam CO2 Transport Hub & Offshore Storage and is the name of the project in which Port of Rotterdam, Gasunie and EBN cooperate to realize a complex CCUS (Carbon Capture Utilisation and Storage) infrastructure.

2. Consultation

As described in the previous chapter, Porthos' aim is to transport CO_2. This CO2 is in gas phase in the onshore pipeline through the Port of Rotterdam. In the compressor station the CO2 is compressed in 4 stages (in fig. from point a to g) to super critical phase (T ±370K; P ±130 bar (see point g in figure) in which it is transported to P-18 (depleted gasfield).



For the project valves are needed, not only in the gaseous phase before the CS but also for the supercritical and liquid phase afterwards.

The overall goal of the consultation is to receive information and to get a confidence level of the manufacturers to what extent their on-off ball valves and pressure equalizing valves are capable to be used in this various CO2 conditions. The information gathered with this consultation will be used to define the best tendering strategy for valves.

2.1. Process parameters/operational conditions

Low pressure pipeline (gas phase) _Onshore

Design pressure: 36 bar(g)

Maximum temperature: 50 °C

Minimum temperature: - 45 °C

Valves are buried, so the operating temperature is expected between 5-50 °C. Temperatures of –45 °C will occur during depressurizing.

Only DN 100 / DN 50 ball valves will be hand operated and installed above ground.

High pressure pipeline (gas phase and dense phase (supercritial and liquid))

Design pressure: 140 bar(g)

Maximum temperature: 90 °C

Minimum temperature: - 45 °C

Valves are buried, so the operating temperature is expected between 5-90 °C, the pressure expected to be between 30-140 bar. We will have all the different phases into the system. The stem extension is above ground so it is exposed by ambient condition which means during wintertime minus temperatures. Temperatures of –45 °C will occur after depressurizing.

Compressorstation

Most of the conditions are the same as for the low pressure – and high pressure pipeline.

Some small valves are above ground and these will be heat traced to avoid fluid formation (for example points for pressure measurement). Some other valves will be exposed to environmental conditions.

If we have for a long period of time at one side pressure and the other side atmospheric what will happen in case of a small leak. We expect cold temperatures and so liquid or even solid formation nearby the seal.

The same can happen for a small leakage through the stem.

Also on the high pressure part we have for a long period of time at one side pressure and the other side atmospheric what will happen in case of a small leak. We expect locally cold temperatures and so liquid formation nearby the seal.

The compressor will be depressurized after each stop of the compressor.

Each year we have a maintenance period on the compressor station and a large part of the compressorstation will be depressurized, also the body of the valve will be depressurized.

2.2. Indication of CO_2 valves needed in onshore pipe line

2.2.1. Low pressure pipeline (gas phase), Carbon Steel

Ball valves

Diameter	Pressure rating ASME	Number
DN 1050	300	5
DN 400	300	19
DN 300	300	2
DN 250	300	16
DN 100 Above ground	300	14
DN 20 Above ground / **SS**	600	7

Pressure equalizing valves

Diameter	Pressure rating ASME	Number
DN 400	300	5
DN 300	300	1
DN 250	300	8
DN 50 Above ground	300	2

2.2.2. High pressure pipeline (gas phase and dense phase (supercritical and liquid)), Carbon Steel

Ball valves

Diameter	Pressure rating ASME	Number
DN 400	900	1
DN 250	900	2

Pressure equalizing valves

Diameter	Pressure rating ASME	Number
DN 250	900	1

2.3. Indication of CO_2 valves needed in compressor station

2.3.1. Ball valves CO2 compressor station suction pressure 40 bar

Ball valves CO2 compressor station suction pressure 40 bar			Number
DN 1050	ball valve CS	40 bar we/we	1
DN900	ball valve CS	40 bar we/we	1
DN450	ball valve CS	40 bar we/we	1
DN450	ball valve SS	40 bar we/we	1
DN400	ball valve CS	40 bar we/we	2
DN350	ball valve CS	40 bar we/we	1
DN350	ball valve SS	40 bar we/we	1
DN300	ball valve CS	40 bar we/we	7
DN300	ball valve SS	40 bar we/we	1
DN250	ball valve CS	40 bar we/we	3
DN100	ball valve CS	40 bar we/we	6
DN100	ball valve CS	40 bar we/fe	2
DN50	ball valve CS	40 bar we/we	20
DN50	ball valve CS	40 bar we/fe	20
DN50	ball valve SS	40 bar fe/fe	12

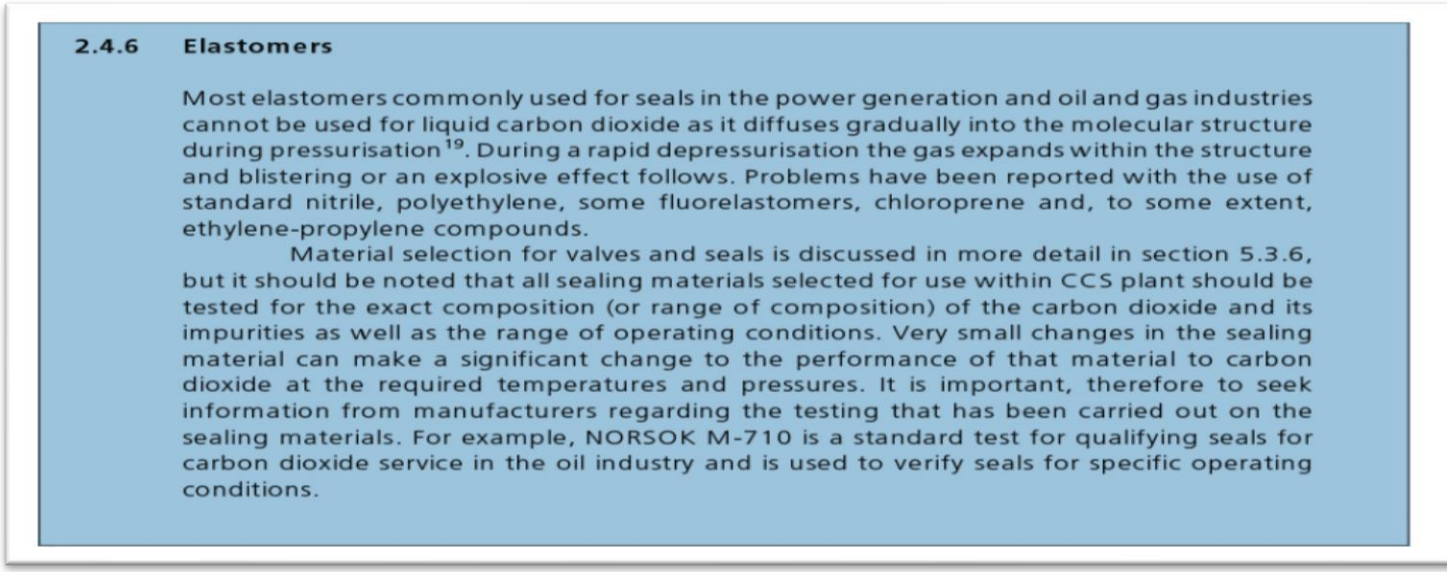
2.3.2. Ball valves CO2 compressor station discharge pressure 140 bar

Ball valves CO2 compressor station discharge pressure 140 bar			Number
DN500	ball valve CS	140 bar we/we	2
DN400	ball valve CS	140 bar we/we	5
DN300	ball valve CS	140 bar we/we	1
DN300	ball valve SS	140 bar we/we	1
DN250	ball valve CS	140 bar we/we	1
DN250	ball valve SS	140 bar we/we	1
DN200	ball valve CS	140 bar we/we	1
DN200	ball valve SS	140 bar we/we	1
DN100	ball valve CS	140 bar we/fe	6
DN 80	ball valve CS	140 bar we/we	3
DN50	ball valve CS	140 bar we/we	20
DN50	ball valve CS	140 bar we/fe	20

2.4. Questions

For response to de following questions, please make use of provided format.

1. What knowledge does your company preserve on applying valves in gas – liquid – supercritical CO2 environment?
2. What tests and/or lab experiments did you perform for working of your valves in CO2 environment? Are you willing to share the test results with Porthos?
3. Describe your experience in supplying valves for the described process parameters:
    a. Which diameter and quantities?
    b. For which industry sector?
    c. When did you deliver the valves?
    d. What delivery times?
4. Describe the way your company monitors the state of the sensitive parts of the valves.
5. Porthos uses GTS MSW-3-E/1 as basis for specification.
    a. Which additions/alterations consultee advises for the soft seals especially?
    b. How does consultee proof the suitability of the soft seals?



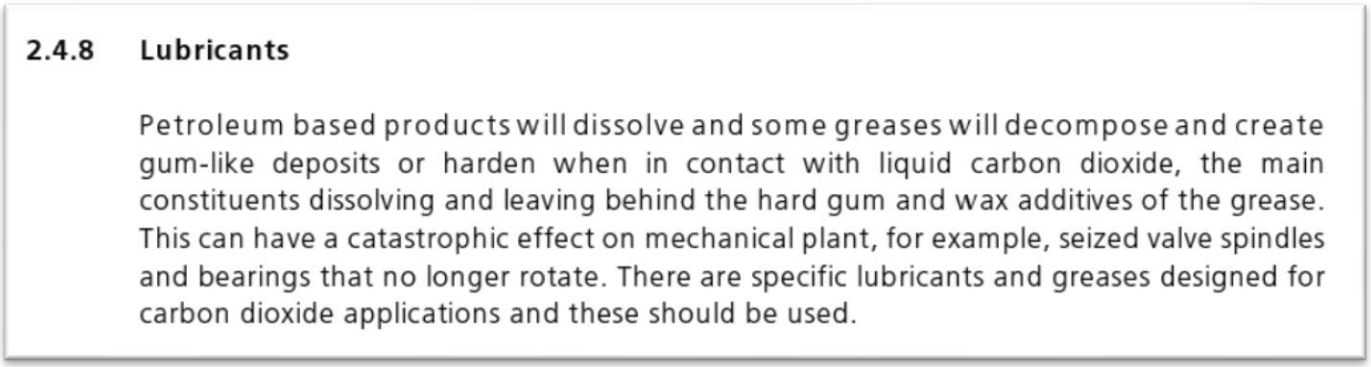
2.4.6 Elastomers

Most elastomers commonly used for seals in the power generation and oil and gas industries cannot be used for liquid carbon dioxide as it diffuses gradually into the molecular structure during pressurisation[19]. During a rapid depressurisation the gas expands within the structure and blistering or an explosive effect follows. Problems have been reported with the use of standard nitrile, polyethylene, some fluorelastomers, chloroprene and, to some extent, ethylene-propylene compounds.

Material selection for valves and seals is discussed in more detail in section 5.3.6, but it should be noted that all sealing materials selected for use within CCS plant should be tested for the exact composition (or range of composition) of the carbon dioxide and its impurities as well as the range of operating conditions. Very small changes in the sealing material can make a significant change to the performance of that material to carbon dioxide at the required temperatures and pressures. It is important, therefore to seek information from manufacturers regarding the testing that has been carried out on the sealing materials. For example, NORSOK M-710 is a standard test for qualifying seals for carbon dioxide service in the oil industry and is used to verify seals for specific operating conditions.

Ref: energy institute "Good plant design and operation for onshore carbon capture installation and onshore pipeline" September 2010.
https://www.globalccsinstitute.com/archive/hub/publications/7276/good-plant-design-and-operation-onshore-carbon-capture-installations-and-onshore-pipelines.pdf

6. What lubricants does consultee advice to use for CO2 (gas – liquid – supercritical) and based on what? Please explain.



2.4.8 Lubricants

Petroleum based products will dissolve and some greases will decompose and create gum-like deposits or harden when in contact with liquid carbon dioxide, the main constituents dissolving and leaving behind the hard gum and wax additives of the grease. This can have a catastrophic effect on mechanical plant, for example, seized valve spindles and bearings that no longer rotate. There are specific lubricants and greases designed for carbon dioxide applications and these should be used.

Ref: energy institute "Good plant design and operation for onshore carbon capture installation and onshore pipeline" September 2010

7. In what way do you monitor the quality provided by the manufacturer(s) of the soft seals?
8. What provisions are made to the valves to prevent pressure build up in the cavity of the valves?

9. Porthos has defined the need for equalizing valves (see draft MTO). What is your advice to Porthos which type of valves to use? Please explain us why of why not.
10. Does the consultee design and manufacture the valves itself?
11. What other recommendations do you have on this subject which we did not ask for in this consultation?
12. Are you willing to present your information via a Teams meeting? And if so, which time slot would be possible for you? Please delete time slot(s) not possible and the persons we need to invite (including e-mail address). We will setup a schedule as soon as possible and send the invitations.

Date	Morning (CEST)	Noon (CEST)
Tue 5th January 2021	9.30 – 12.00	13.30 – 16.00
Wed 6th January 2021	9.30 – 12.00	13.30 – 16.00
Thu 7th January 2021	9.30 – 12.00	13.30 – 16.00

3. Consultation process

3.1. Schedule

Activity	Date / Period
Publication of the document via TenderNed	Mon 23rd November 2020
Possibility to pose questions about the consultation document, 10:00 hr	Mon 7th December 2020
Publication of answers on questions via TenderNed	Wed 9th December 2020
Deadline submission of response via e-mail j.draijer@gasunie.nl	Wed 16th December 2020
Dialogue (ca. 2 hrs) about impact on CO2 on valves	5, 6, 7 January 2021

3.2. Exchange of information

The exchange of information for this consultation is carried out electronically through TenderNed, www.tenderned.nl. The use of TenderNed is free of charge.

Response to the questions is to be done by e-mail to j.draijer@gasunie.nl.

3.3. Conditions

By taking part in this consultation you agree with the following conditions:

1. Responses must be sent via email to the contact person of this consultation;
2. All documents and communication in English;
3. Your response is confidential and shall only be shared within Porthos and Gasunie;
4. The provided information will only be used for further studies and advice to develop optimal tender package(s);
5. Porthos has the right to use information in a possible upcoming public procurement tender but is not obliged to do so;
6. Porthos is not bound by the results of this consultation;
7. The number of presentations is in principle limited to 6 presentations. In case the responses outnumber the presentations, Porthos has the right to select presentations and/or extend with an extra presentation day. Responder cannot claim a right for presentation.
8. Participants cannot derive any rights based on this consultation;

3.4. Response

Please send your reaction via e-mail to:

Johan Draijer, j.draijer@gasunie.nl.