CO_2 Scrubbing onboard Walrus Class an overview

By Toon Mariën
RNLNAVMAINEST

Topics

- Introduction
- History
  - Scubbers 1 and 2 (original view)
  - Prototype 3rd scrubber
  - WCA (Working Conditions Act)
  - Powercube and powercube adapter (first test)
  - Nesquick test
  - Overview of all three scrubbers after build and implementation of 2nd generation third scrubber
- Combined conclusions
- Improving airflow
- What now
  - Trials
- Q&A

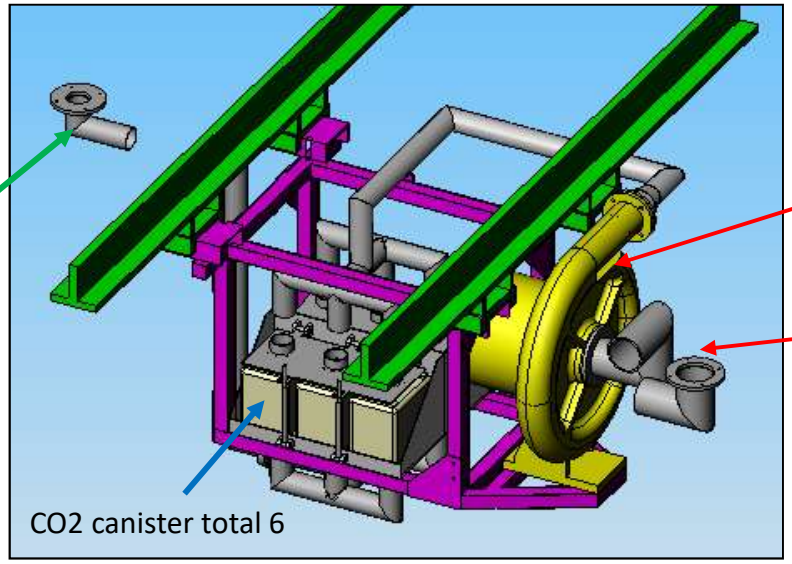
Scrubber original view

- During the build of the Walrus class, 8 scrubbers for scrubbing CO2 were build and implemented
- 2 scrubbers were installed on each Submarine
- Positioned in Wardroom and Torpedo storage room
- The scrubber made use of canisters filled with Sodalime Granuals

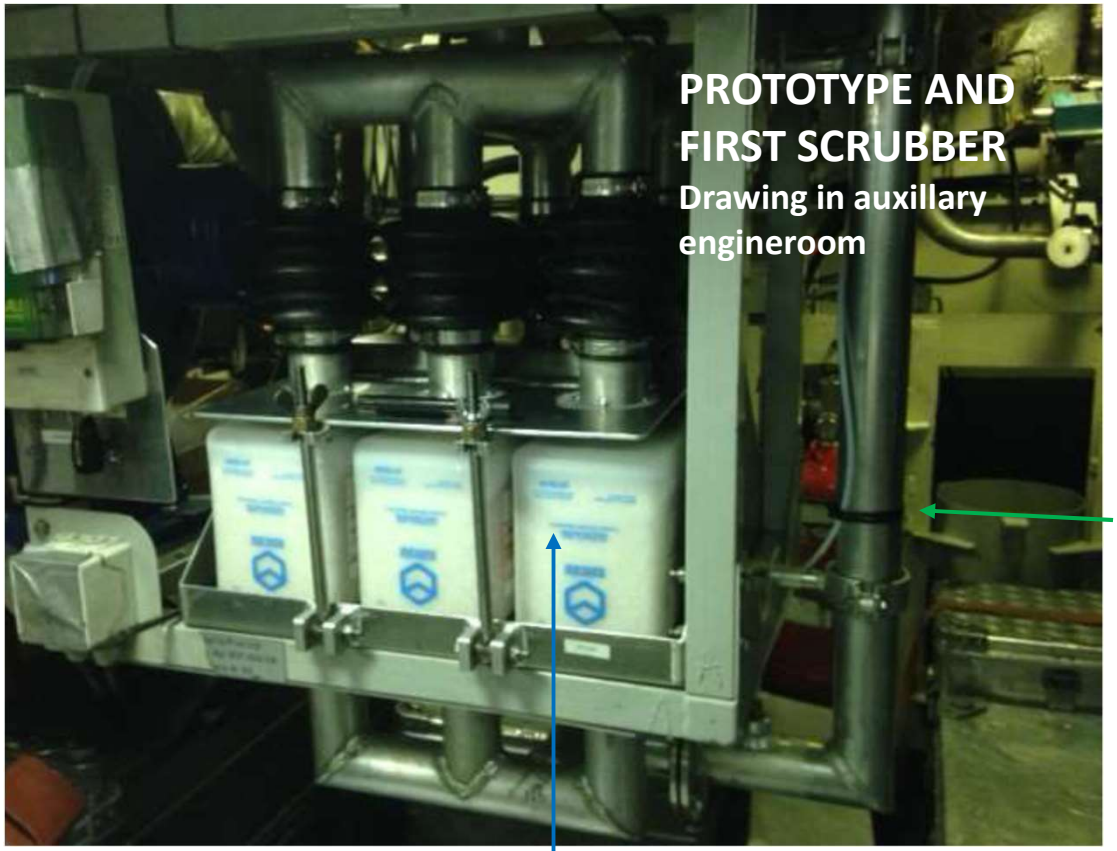
Prototype 3rd scrubber

- Already during the first few years it became clear that the scrubbers were not performing as expected.
- So throughout the years RNLN made small changes, as air flow rate and internal cannister changes by OEM.
- In 2007 there was a study upon improving CO2 scrubbing, one of the conclusions was that more volume of adsorbing material was needed , even with 100% use of the canisters in the two existing scrubbers. **This resulted in a 3rd scrubber**

PROTOTYPE AND FIRST SCRUBBER
drawing



There was a slight but not sufficient improvement so further research was done



Connection to
mechanical vent
exhaust ducting of SUB

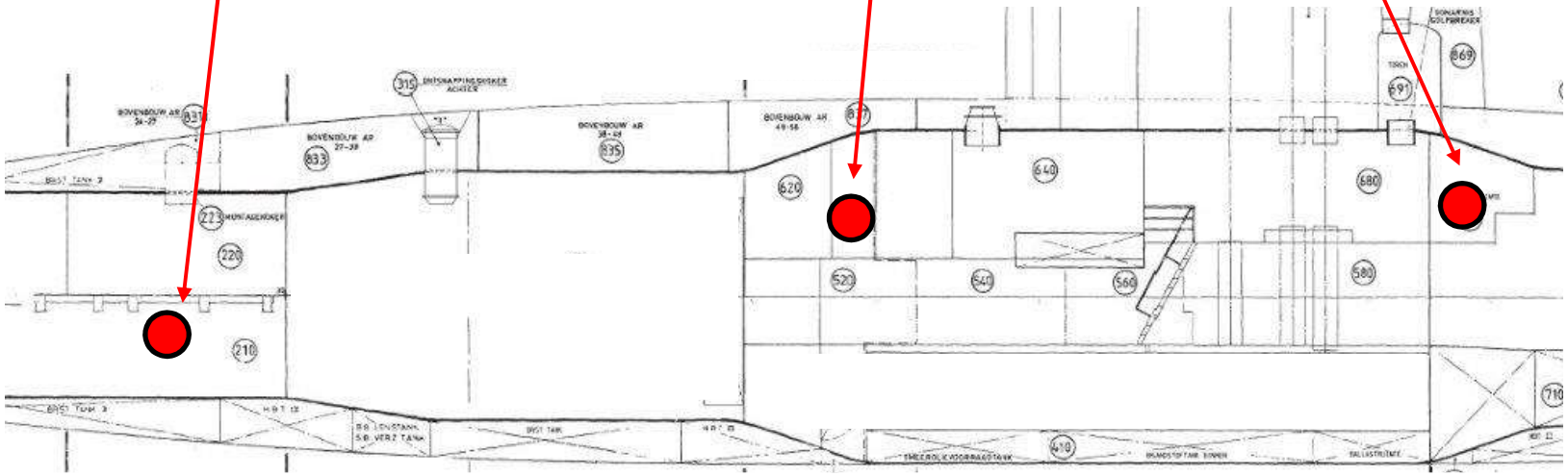
CO2 canister, 6 in total

Positions of the three scrubbers

Proto type - and now 2nd generation scrubber Auxiliary Engineroom

Original type scrubber Wardroom

Original type scrubber Torpedoroom



- From start of operating Walrus class untill 2013/2014, the MAC values of CO_2, were a maximum level of 1.5% (no designated time limit), and a 24 hours maximum level of 2%.
- The third (prototype) scrubber brought some improvements.

- With a new POR for new canisters the responsible department of the Defense Material Organization was triggered on the MAC levels
- At the end of 2013 a research was initiated on admissible CO_2 levels, this resulted in new MAC levels for CO_2 on Netherlands submarines

Changes in WCA

- After a study on values to be in forced on submarines RNLN decided that we had to go down with .5% on our values now resulting in a CO2 operational maximum for 1%, and a 24 hours maximum level of 1,5%.

- During 2014 and 2015 RNLN did several tests, first test (Power cube test)was presented at SAMAP 2015. This made RNLN switch from granual canisters to the Powercube adapter and the CaOH power cubes. (next slide)
- A other test was ("The Nesquick" test) on the internal airflow on the original two scrubbers. Also presented at SAMAP 2015 (by Barend van der Giesen)

"The Nesquick" test

Internal airflow or the a first test of
performance of the seperate canisters
and the airflow through the seperate canister.

Powercube test

- RNLN, together with manufacturer of the Powercube adapter and the 2 different Powercube blocks wanted to perform an on board test. So in 2014 RNLN performed a test on board submarine Dolfijn.

- The Power cube adapter
- 2 different kinds of scrubbing material blocks (CaOH- and LiOHPowerCube)
- This was presented at SAMAP 2015

Powercube adapter with Calcium Hydroxide block, VM-1050P(Micropore)

Overview of all three scrubbers

(current situation)

Torpedo storageroom

Third scrubber final design

Auxiliary Engineroom

Wardroom

combined conclusions

The combined conclusions of these test were:

- Install a third scrubber
- Use the Micropore powercube adapters in combination with the Micropore calcium hydroxide blocks (Powercube)
- Improve airflow through the two existing scrubbers

After implementing the first two conclusions the CO2 levels on board submarines improved and even became lower than expected. Although RNLN did not perform an endurance test up to this moment

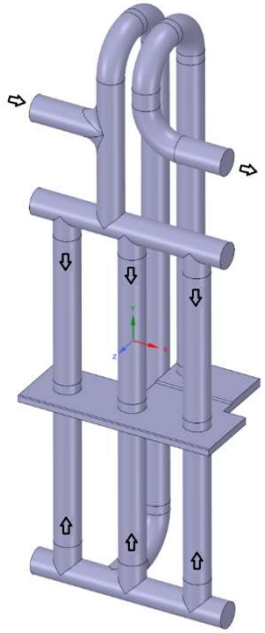
The third conclusion is work in progress. In 2018 a company performed CFD analysis on both old scrubbers and were asked for suggestions on improving the internal airflow

With a small change on a part of the scrubber the airflow can be improved to get an almost evenly airflow through all powercubes.

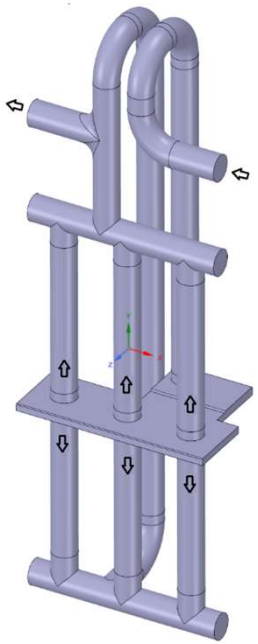
RNLN implemented this improvement on one of the submarines and is looking for an opportunity for testing

Improving airflow

- To improve the airflow thoughout the two existing scrubbers van asked DECOM bunova to do some research on our scrubbes (Wardroom and Torpedo storageroom)

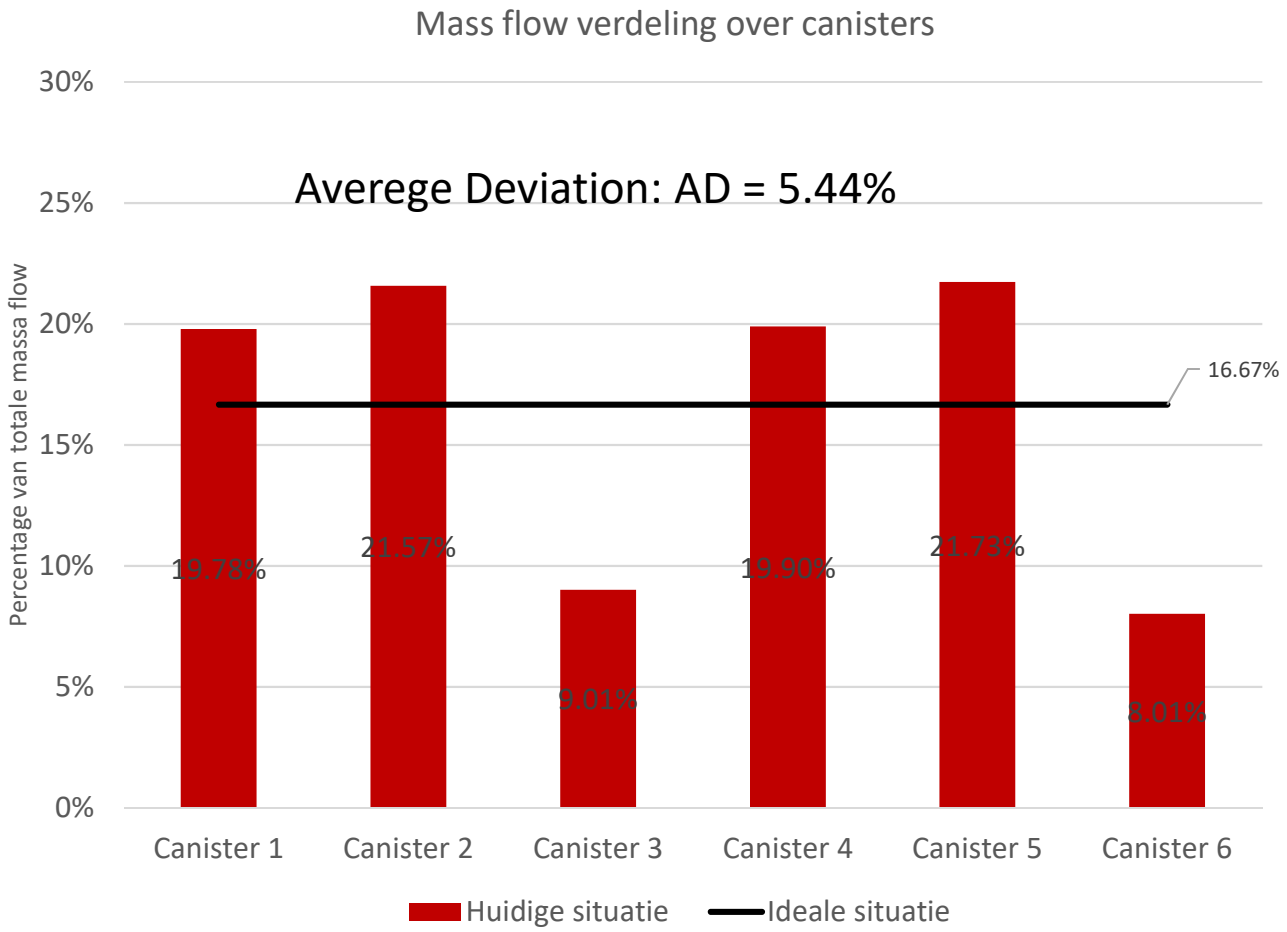


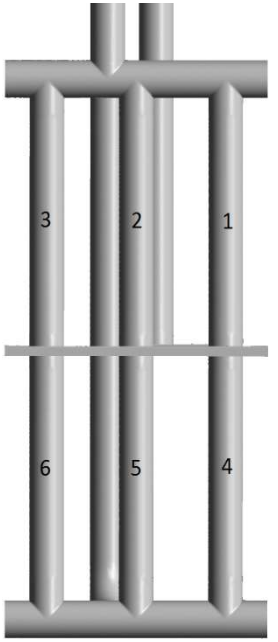
Wardroom



Torpedo storageroom

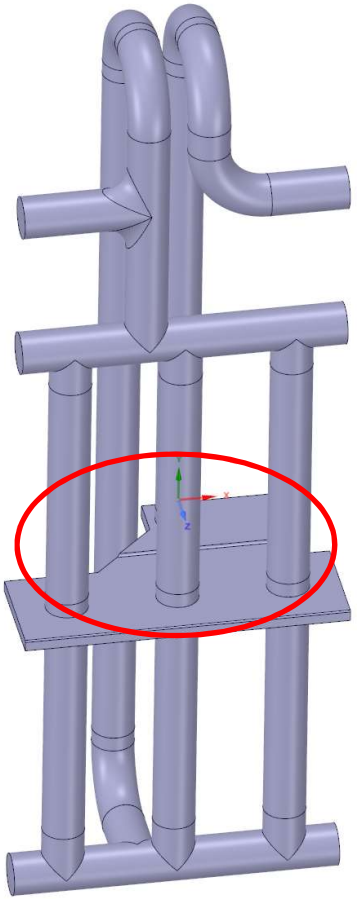
Mass flow distribution CO_2 unit Torpedo storageroom

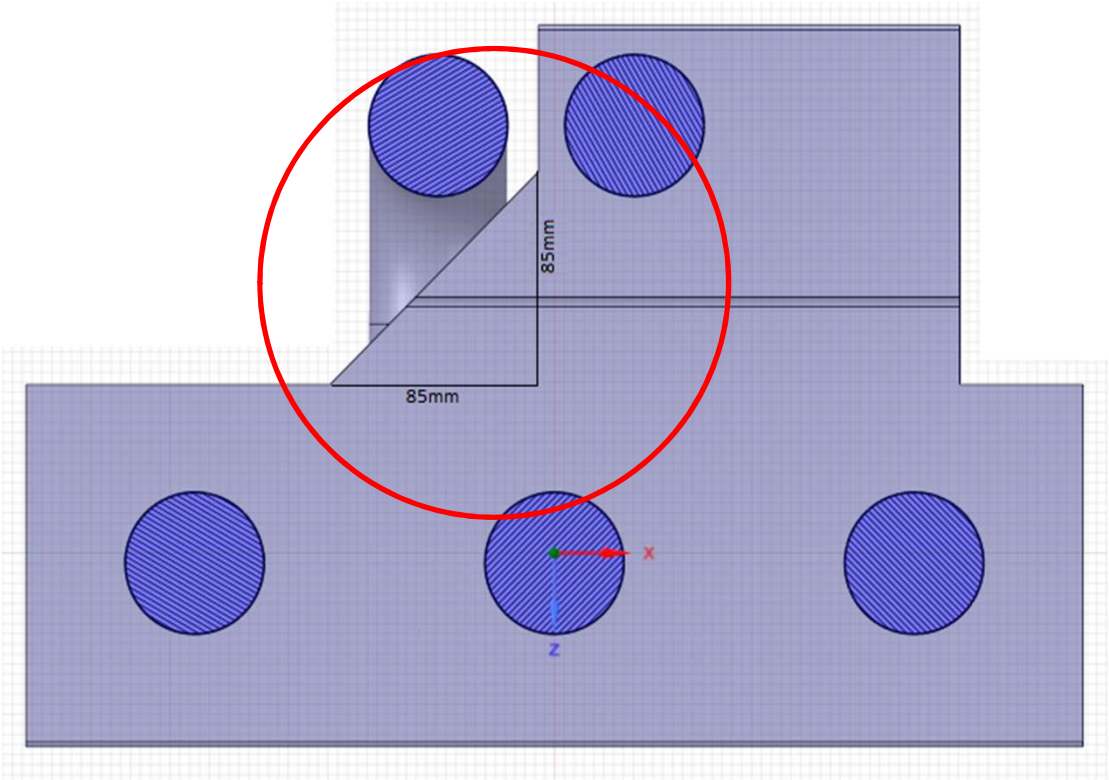




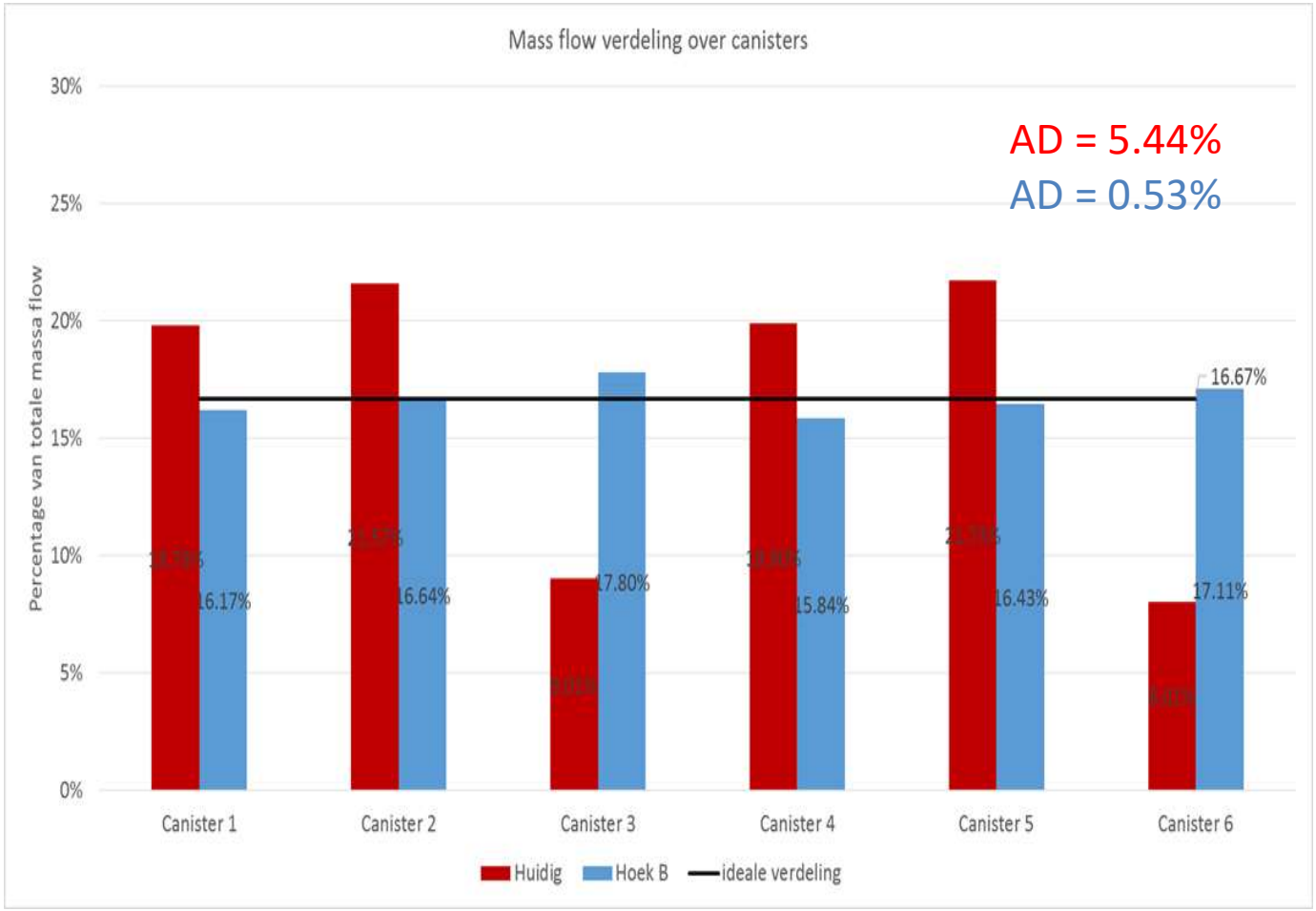
- Two left canisters (3 en 6) have little mass flow

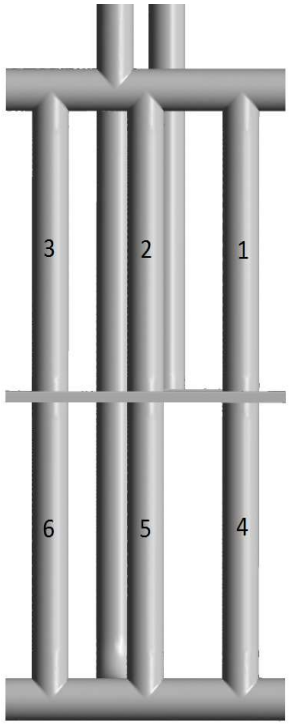
- After some modelling and calculations the conclusion was that the change as suggested with line B was the best solution for both scrubbers





Mass flow distribution CO_2 unit Torpedo storageroom after implementing change B

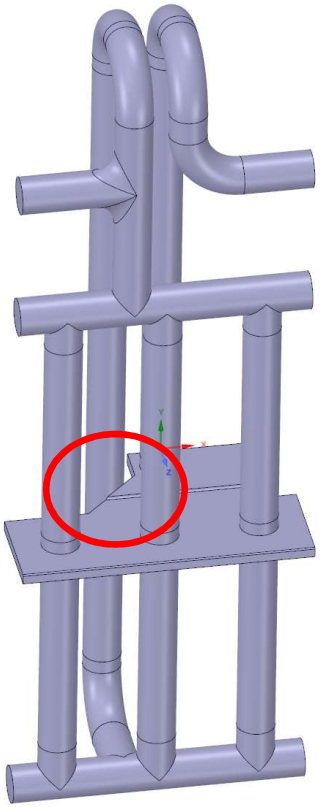


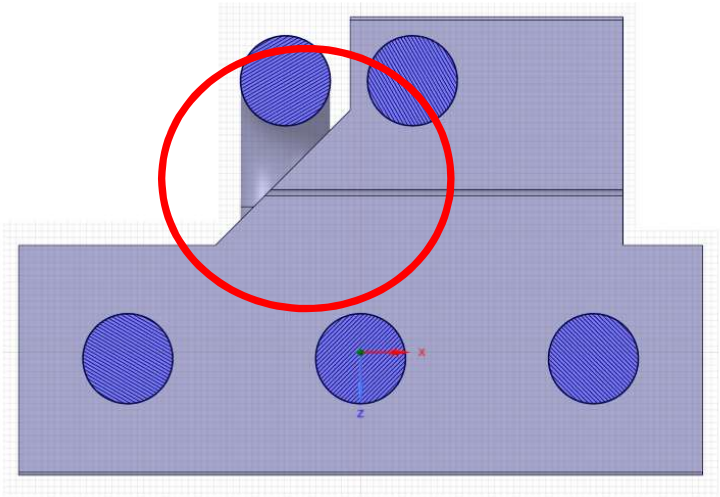


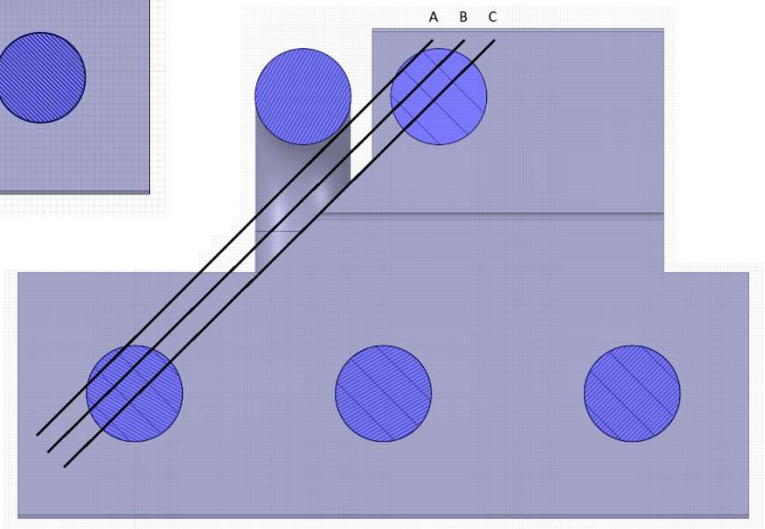
- Mass flow distibution improved approaching the Ideal line of 16.67%

- The improvement on the Wardroom scubber was significant less than the improvement on the Torpedo storageroom scrubber. Never the less RNLN made the change on the scrubber.
- The Average Deviation on the wordroom scrubber is under 1%
- No graphs or pictures on the Wardroom scrubber about air flow are available in this presentation

Adjustment for improving mass flow distibution







What now?

- RNLN has mounted a third scrubber (final design) and made the changes to the two existing scrubbers on one of our submarines .
- This coming fall RNLN will implement the changes to the two scrubbers on the second submarine
- Perform a quayside- and sea trial

Trials

How to trial CO2 scrubbing on board a Walrusclass submarine?

PLAN:

- 1st, Perform a static quayside trial, like RNLN did before, find a few a bit crazy guys, Put these guys in a closed down submarine, give them fire extinguishers, have them discharge aprox 2,8 kg CO_2 /hour into the submarine for simulating a crew of 62 and let them measure:
  - CO_2 ;
  - O_2 ;
  - temperature ;
  - humidity

- 2nd Perform sea trial to look at the performance under real life submarine conditions,

Questions

maybe answers !!!!