

Verneutstyr og funksjon i kaldt klima

HMS utfordringer i Nordområdene – Arbeidsseminar 2

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Bakgrunn

Statoils har hatt ulike FoU prosjekt for å teste funksjon av åndedrettsvern:

- JIP Hot work respiratory protection, 2006 – 2008.
- JIP/Statoil: Test av beskyttelsesfaktor for 4 ulike **filter** ved ulike temperaturer (-15, 0, 20 og 35°C) og ulike luftfuktigheter (20% og 80%). Testet for BTX, isocyanater, kvikksølv og partikler.
- Statoil: test av 3 åndedrettsvern ved ulike temperaturer (-25, -10, 5 og 20°C). Klimakammer, testpersoner, standardiserte oppgaver.

Institutet
For Kemisk Analyse Norden AB


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2009-05-20

2012-08-09

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ConocoPhillips
U.K., Alaska



Statoil


Test of respiratory protection devices in cold climate

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1. Objective

Statoil has completed a study for testing the performance of respiratory protection devices in cold climate. The aims of the study were to investigate if the protection factor of different respirator masks was influenced by the temperature during use and if the user experience was influenced by the temperature during use. Further, the test was designed to address which of the respirators performed best at low temperature (if any difference occurred), and if ice formation or water condensation in- or outside the mask was an issue.


Figure 1 Photo of a test person inside the climate chamber




A: Half-face mask, negative pressure



B: Full-face mask, negative pressure




C: Full-face mask with fan assistance



2. Methods

Three different respiratory devices, see Figure 1, have been tested at the temperatures +20, +5, -10 and -25°C. The tests were carried out in a climate chamber at the vendor facility (IFKAN) with fully controlled environmental conditions. The performance involved three test persons representing different facial dimensions (anthropometric data), who performed standardized tasks inside the climate chamber in accordance with a procedure (EN 136: 1995). The fit testing was performed using aerosol of salt particles, in order to use non-toxic test compounds. The particle concentration were monitored inside and outside the respirators simultaneously with a particle counter (TSI CPC 3007), and the activities were documented on video (ParticleView software). The test subjects filled out a questionnaire regarding their user experiences.

Figure 2 Photo of a test person inside the climate chamber



3. Results

The results show that in general, the full-face mask with fan assistance had good protection factor during all the tests, had no condensation on sight glass, and its performance was not affected by temperature. However, the user friendliness was low when cold air was sweeping against unprotected face skin. It was uncomfortable at +10°C, and it was unbearable at -10°C. The half-face and full-face masks had acceptable protection factor, but introduced other effects like influence of anthropometric variance and of handling. Further, the full-face mask had low visibility below 0°C due to condensation. The use of a tightening lid decreased condensation at -10°C, but it required a certain breathing rate to work properly. Clearly, the fan assisted respiratory protection device was the most robust device. However, there is a need to look into how to pre-heat the air to improve the user friendliness before a recommendation of use in cold climate.


Table 1 Summary of results

Respirator	General remarks	Temperature tested	User friendliness
A	Acceptable protection factor during all the tests. Protection factor not affected by temperature. No condensation on sight glass, and its performance was not affected by temperature. However, the user friendliness was low when cold air was sweeping against unprotected face skin. It was uncomfortable at +10°C, and it was unbearable at -10°C. The half-face and full-face masks had acceptable protection factor, but introduced other effects like influence of anthropometric variance and of handling. Further, the full-face mask had low visibility below 0°C due to condensation. The use of a tightening lid decreased condensation at -10°C, but it required a certain breathing rate to work properly. Clearly, the fan assisted respiratory protection device was the most robust device. However, there is a need to look into how to pre-heat the air to improve the user friendliness before a recommendation of use in cold climate.	Performance not affected by temperature.	Uncertain below +10°C.
B	Acceptable protection factor during all the tests. Protection factor not affected by temperature. No condensation on sight glass, and its performance was not affected by temperature. However, the user friendliness was low when cold air was sweeping against unprotected face skin. It was uncomfortable at +10°C, and it was unbearable at -10°C. The half-face and full-face masks had acceptable protection factor, but introduced other effects like influence of anthropometric variance and of handling. Further, the full-face mask had low visibility below 0°C due to condensation. The use of a tightening lid decreased condensation at -10°C, but it required a certain breathing rate to work properly. Clearly, the fan assisted respiratory protection device was the most robust device. However, there is a need to look into how to pre-heat the air to improve the user friendliness before a recommendation of use in cold climate.	Performance not affected by temperature.	Allowing low visibility below 0°C. No condensation on sight glass.
C	Acceptable protection factor during all the tests. Protection factor not affected by temperature. No condensation on sight glass, and its performance was not affected by temperature. However, the user friendliness was low when cold air was sweeping against unprotected face skin. It was uncomfortable at +10°C, and it was unbearable at -10°C. The half-face and full-face masks had acceptable protection factor, but introduced other effects like influence of anthropometric variance and of handling. Further, the full-face mask had low visibility below 0°C due to condensation. The use of a tightening lid decreased condensation at -10°C, but it required a certain breathing rate to work properly. Clearly, the fan assisted respiratory protection device was the most robust device. However, there is a need to look into how to pre-heat the air to improve the user friendliness before a recommendation of use in cold climate.	Performance not affected by temperature.	Clear at sweeping against unprotected face. No condensation on sight glass. No condensation at +10°C.

2

Classification: Internal

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Formål med studien

Hovedspørsmål

1. Påvirkes beskyttelsesfaktoren til åndedrettsvern av temperaturen de brukes i?
2. Påvirkes brukervennligheten til åndedrettsvern av temperaturen de brukes i?

Sekundære spørsmål

1. Hvilket åndedrettsvern yter best ved lav temperatur (hvis det er forskjell)?
2. Er isdannelse eller kondensering inni eller på utsiden av masken et problem?

Åndedrettsvern i testen:

Respirator model	Description	Manufacturer
SR 90-3 TPE	Half-face mask, negative pressure respirator	Sundström
SR 200	Full face mask, negative pressure respirator	Sundström
SR 200 with SR 500 EX	Fan assisted respirator, full-face mask	Sundström

SR 90-3



SR 200



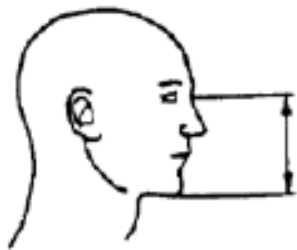
SR 200 with SR 500 EX



Test personer

Table 5.4 Anthropometric data on the persons performing the respirator tests.

Test person	Age (years)	Facial dimensions (mm, Figure 5.21)			
		A	B	C	D
A	21	125	129	149	55
B	26	120	125	137	62
C	22	115	120	132	52



A

Length of face
(nasion-menton)



B

Width of face
(bizygomatic diameter)



C

Depth of face



D

Width of mouth

Figure 5.21 Definition of facial dimensions in Table 5.4 according to standard EN 140.

Test matrise

	SR90-3 TPE (Half- mask)	SR200 (Full face – mask)	RS200 + SR500 EX (Fan assisted Full face – mask)
<i>Test temperature -25 °C</i>	Mask 1	Mask 2	Mask 3
Clean shaved	3 repetitions	3 repetitions	3 repetitions
With beard stubble	3 repetitions	3 repetitions	Not included in this study
<i>Test temperature -10 °C</i>	Mask 1	Mask 2	Mask 3
Clean shaved	3 repetitions	3 repetitions	3 repetitions
With beard stubble	3 repetitions	3 repetitions	Not included in this study
<i>Test temperature 5 °C</i>	Mask 1	Mask 2	Mask 3
Clean shaved	3 repetitions	3 repetitions	3 repetitions
With beard stubble	3 repetitions	3 repetitions	Not included in this study
<i>Test temperature 20 °C</i>	Mask 1	Mask 2	Mask 3
Clean shaved	3 repetitions	3 repetitions	3 repetitions
With beard stubble	3 repetitions	3 repetitions	Not included in this study

Test compound: aerosol of salt particles (non-toxic test compound).

Test prosedyre

Fit test was performed according to EN 136:1998:

1. Cycling without head movement or talking for 2 minutes.
2. Cycling: Turning head from side to side (15 times), as if inspecting the walls of a tunnel for 2 minutes.
3. Cycling: Moving head up and down (15 times), as if inspecting the roof and floor for 2 minutes.
4. Cycling: Reciting a text, in our case the “The rainbow passage”, out loud as if communicating with a colleague for 2 minutes.
5. Cycling without head movement or talking for 2 minutes.

Total test time: 35 minutes (with a total of 14 minutes of acclimatization time and preparative measurements also described in the standard)

Foto fra testen






Kontrollrom



Vindu for visuell kontakt mellom kontrollrom og testkammer



Resultater

Respirator	General remarks	Temperature effect	User friendliness
	<p>Acceptable protection factor during most of the tests.</p> <p>Fitting to face affected by anthropometric variance, and affected by handling</p>	<p>Performance not affected by temperature.</p>	<p>Uncomfortable below -10°C.</p>
	<p>Acceptable protection factor during most of the tests. Condensation on sight glass below +5°C.</p> <p>Fitting to face affected by anthropometric variance, and affected by handling.</p>	<p>Performance not affected by temperature.</p>	<p>Alarming low visibility below +5°C due to condensation.</p>
	<p>Good protection factor during all the tests.</p> <p>Fitting to face unaffected by anthropometric variance, and unaffected by handling.</p>	<p>Performance not affected by temperature.</p>	<p>Cold air sweeping against unprotected skin, uncomfortable at 5°C, unbearable at -10°C.</p>

Kondensasjon inne i helmaske - 1



SR 200 mask without tightening lid

SR 200 mask with tightening lid

Figure 6.18 Pictures showing a SR 200 mask without and with a tightening lid.

Kondensasjon inne i helmaske - 2

-10°C with tightening lid



1 min



5 min



10 min



20 min

-10 °C without tightening lid



1 min



5 min



10 min



20 min

Kondensasjon inne i halvmaske



Figure 6.21 The picture is showing condensed water in a SR 90-3 TPE after a test performed in $-25\text{ }^{\circ}\text{C}$.

Konklusjon

- Helmasken med batteridrevet filterenhet hadde god beskyttelsesfaktor i alle testene. Den hadde ikke kondensering på glasset, og ytelse var ikke påvirket av temperatur. Brukervennligheten var lav når kald luft strømmet over ubeskyttet ansiktshud; det var ukomfortabelt ved 5°C og uutholdelig ved -10°C.
- Halvmasken og helmasken hadde akseptabel beskyttelsesfaktor, men introduserte andre effekter som antropometrisk innflytelse og variasjon i håndtering. Helmasken hadde dårlig sikt under 5°C pga kondensering. Ved å montere en «tightening lid» inni maska kunne kondenseringen reduseres ved -10°C, men dette krevde en viss pustehastighet for å virke godt.
- Helmasken med batteridrevet vifteenhet var mest robust av de som ble testet. Her er det imidlertid et behov for å se nærmere på forvarming av lufta for å øke brukervennligheten. Produsenten anbefaler ikke bruk i lavere temperatur enn -10°C. Hvordan batteri og materialer vil oppføre seg i lavere temperaturer var ikke en del av studien.

Hva med hørselvern i kalde omgivelser?

Studie bestilt av prosjektet «Støy i petroleumsnæringen» hos SINTEF:

- Måling av støydemping til øreklokker i kombinasjon med vernebriller og balaklava

Uttrekk fra konklusjonen:

«En dårlig egnet balaklava reduserer ytelsen (til hørselvernet) med 15-20 dB. Balaklavaer som har få sømmer, tynt, enkelt ettersittende stoff, vil fungere rimelig godt, og gi en redusert demping på ca 4-5 dB.»



There's never been a better
time for **good ideas**

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