UNIVERSITY OF ICELAND
SCHOOL OF ENGINEERING AND NATURAL SCIENCES
FACULTY OF INDUSTRIAL ENGINEERING, MECHANICAL ENGINEERING AND COMPUTER SCIENCE

matís

Áhrif hitasveiflna á frosið sjávarfang

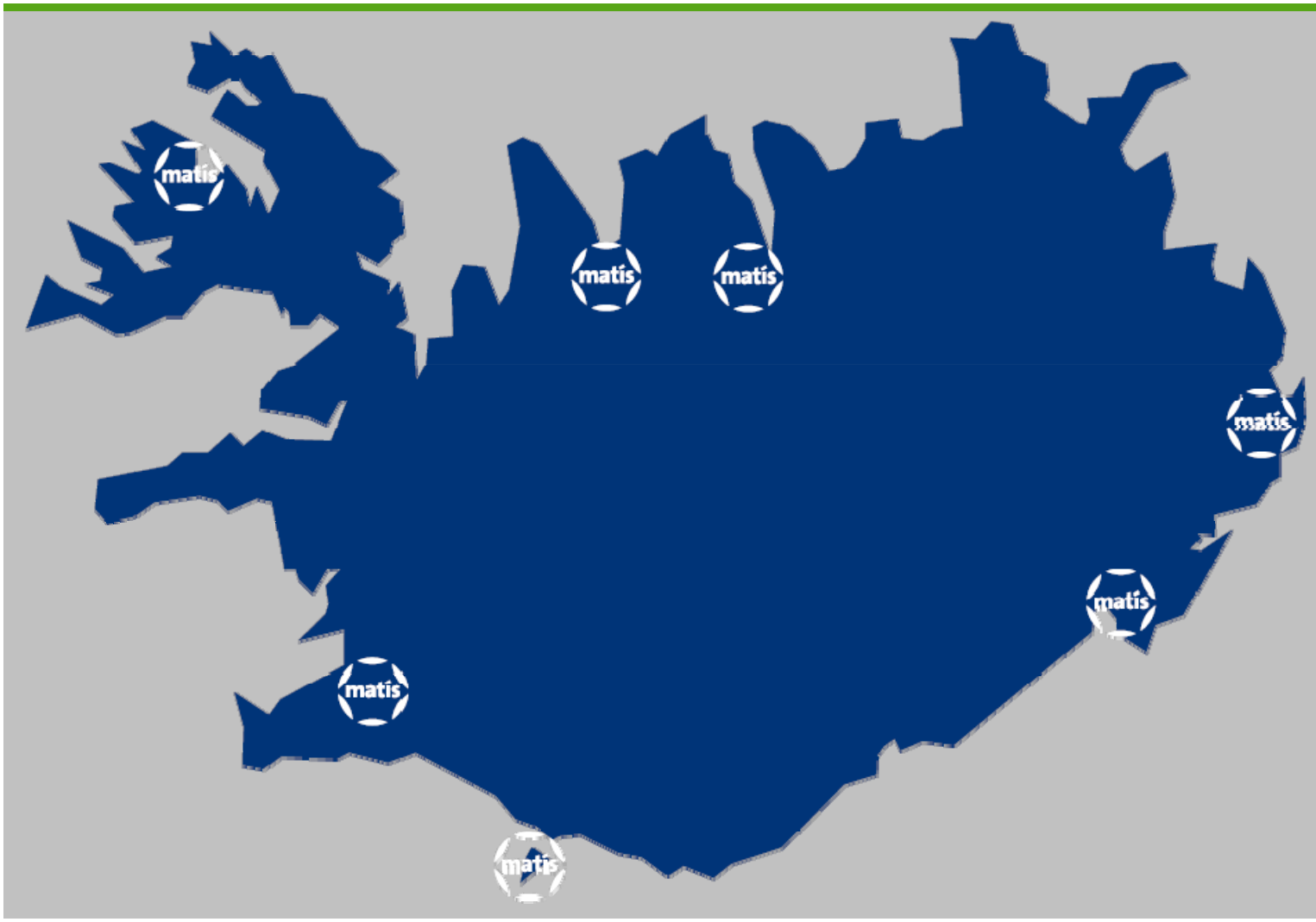
Aðalfundur Kælitæknifélags Íslands
10. nóv. 2009

Björn Margeirsson, M.Sc.
Vélaverkfræðingur og doktorsnemi Matís og HÍ

Sigurjón Arason, M.Sc.
Yfirverkfræðingur Matís og dósent HÍ

Dagskrá

Hjá Matís starfa um 90 manns



Vörumerki

PROKARIA

Dótturfyrirtæki

iceprotein

Vel menntaðir sérfræðingar af ólíkum sviðum

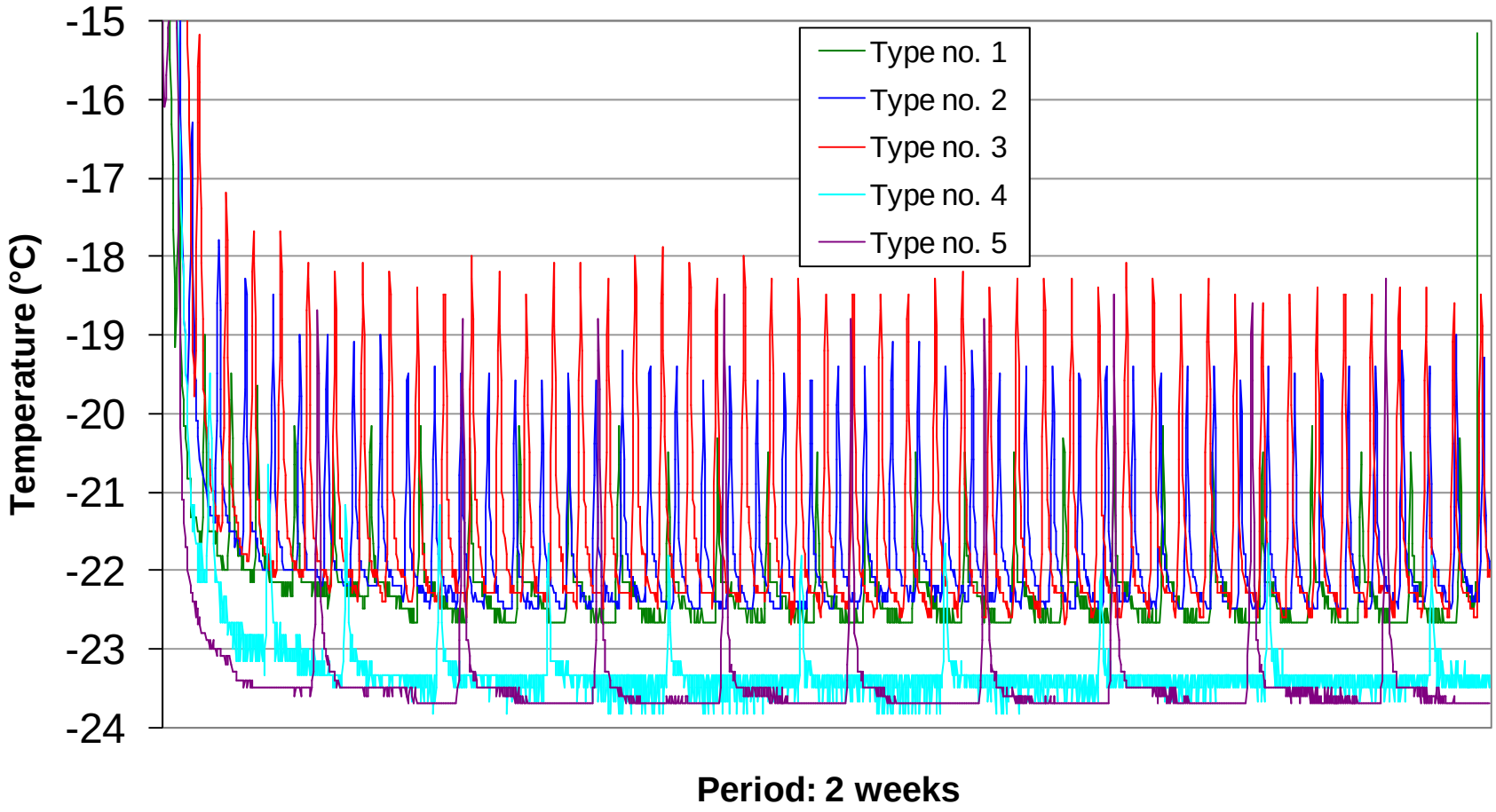
- **Verkfræðingar**
- **Matvælafræðingar**
- **Líffræðingar**
- **Efnafræðingar**
- **Sjávarútvegsfræðingar**
- **Tæknimenntað fólk- kjöt, mjólk og fiskur**

Bakgrunnur starfsfólk er fjölbreyttur og kemur að góðum notum fyrir samstarfsaðila Matís.

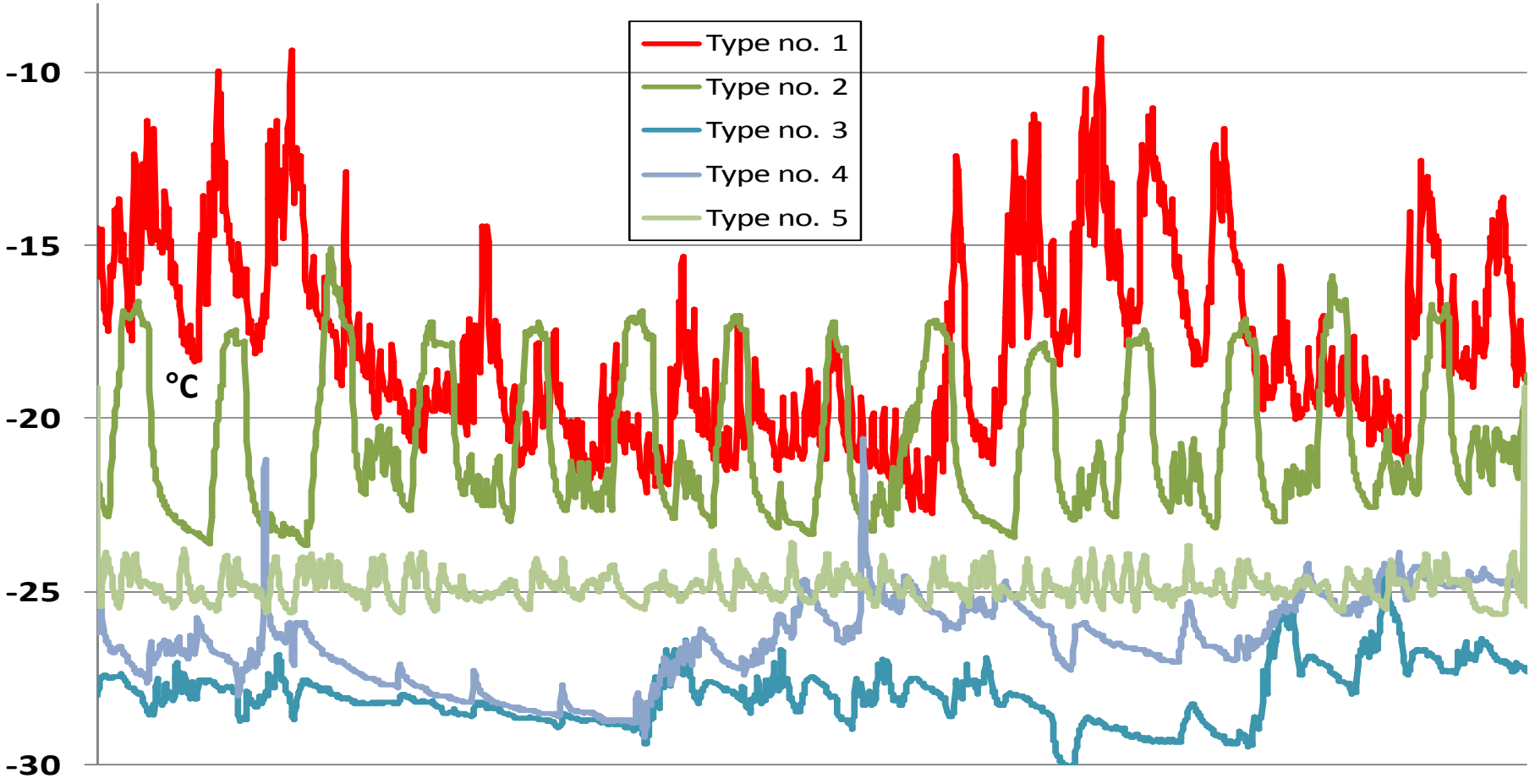
Helstu markmið Matís

- **Efla samkeppnishæfni íslenskra afurða og atvinnulífs**
- **Tryggja matvælaöryggi og sjálfbæra nýtingu umhverfisins með rannsóknum, nýsköpun og þjónustu**
- **Bæta lýðheilsu**

Temperature monitoring in containers average temperature, set point value: -24 °C

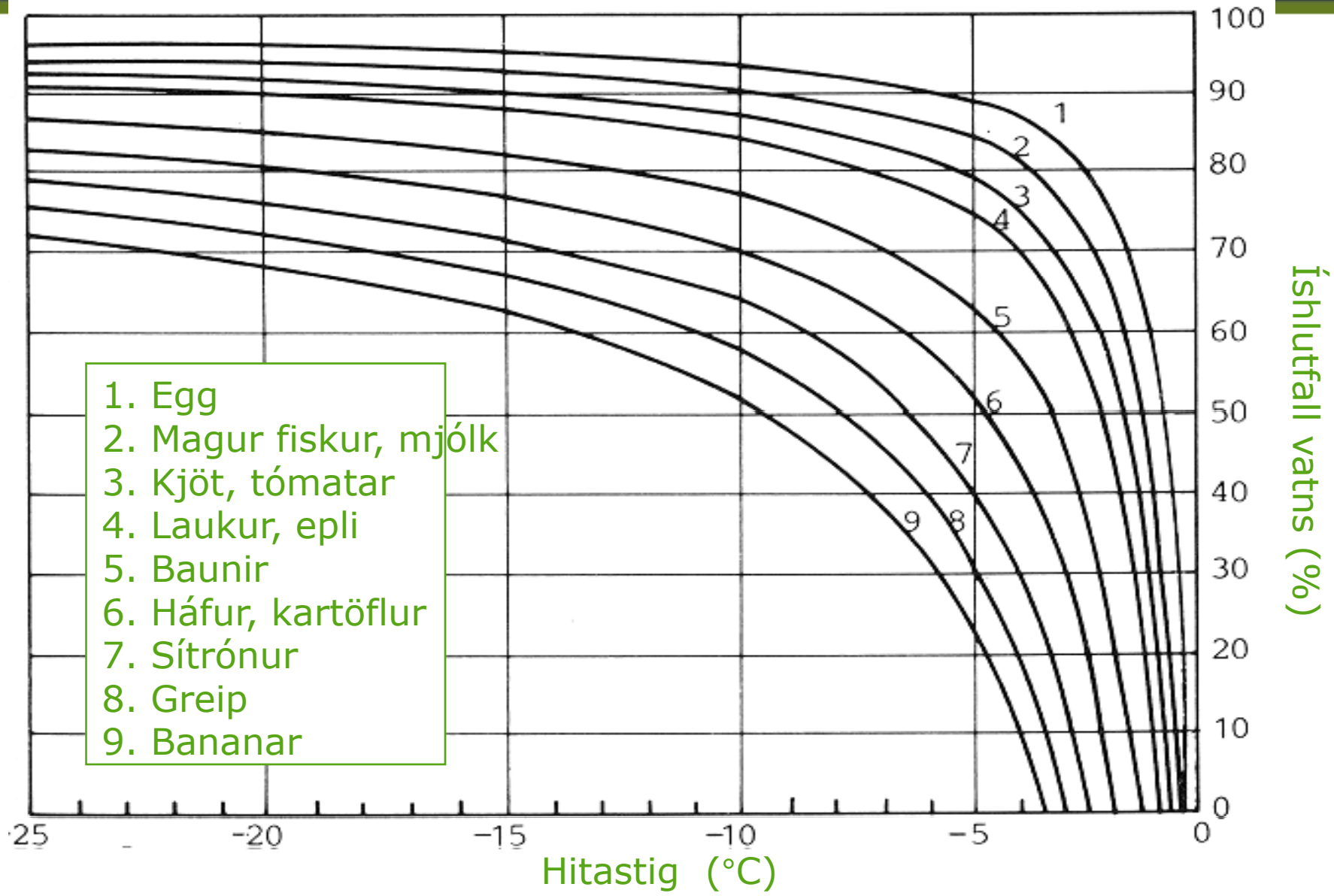


Temperature monitoring in cold stores
average temperature, set point value: -25 C

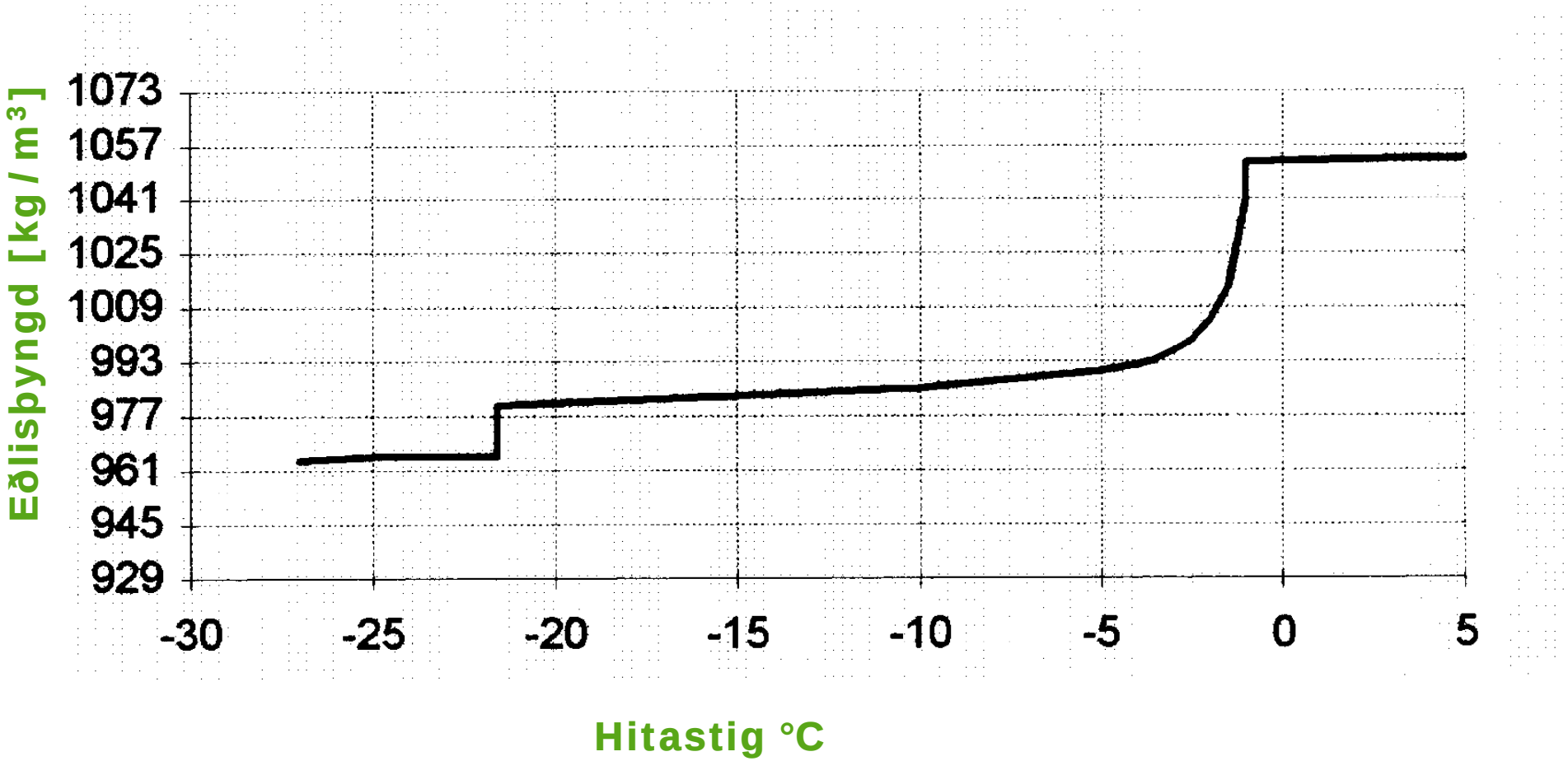


Duration: 2 weeks

Íshlutfall vatns í matvælum við mismunandi hitastig

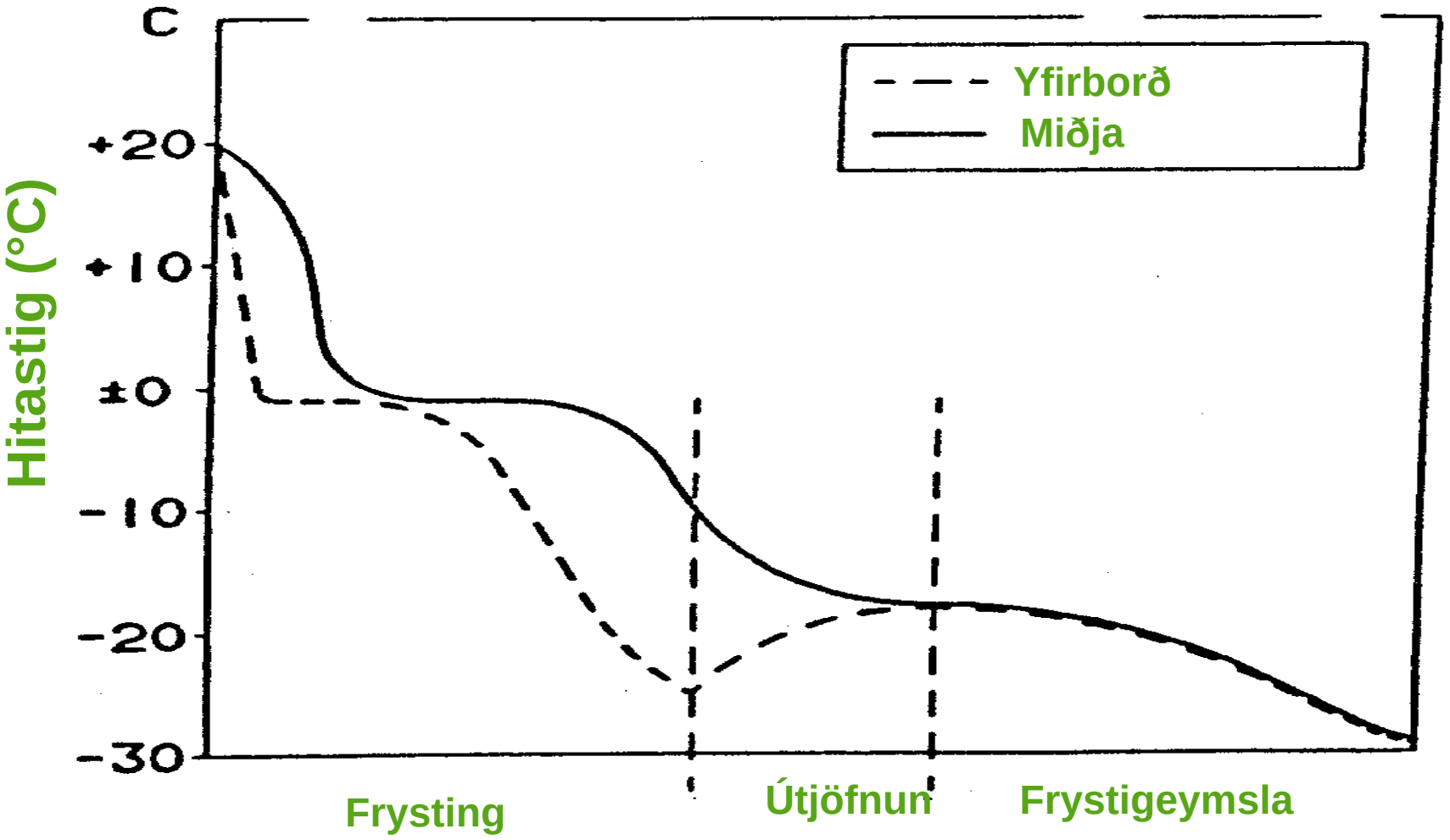


Breytingar í eðlisþyngd þorskavöðva með hitastigi



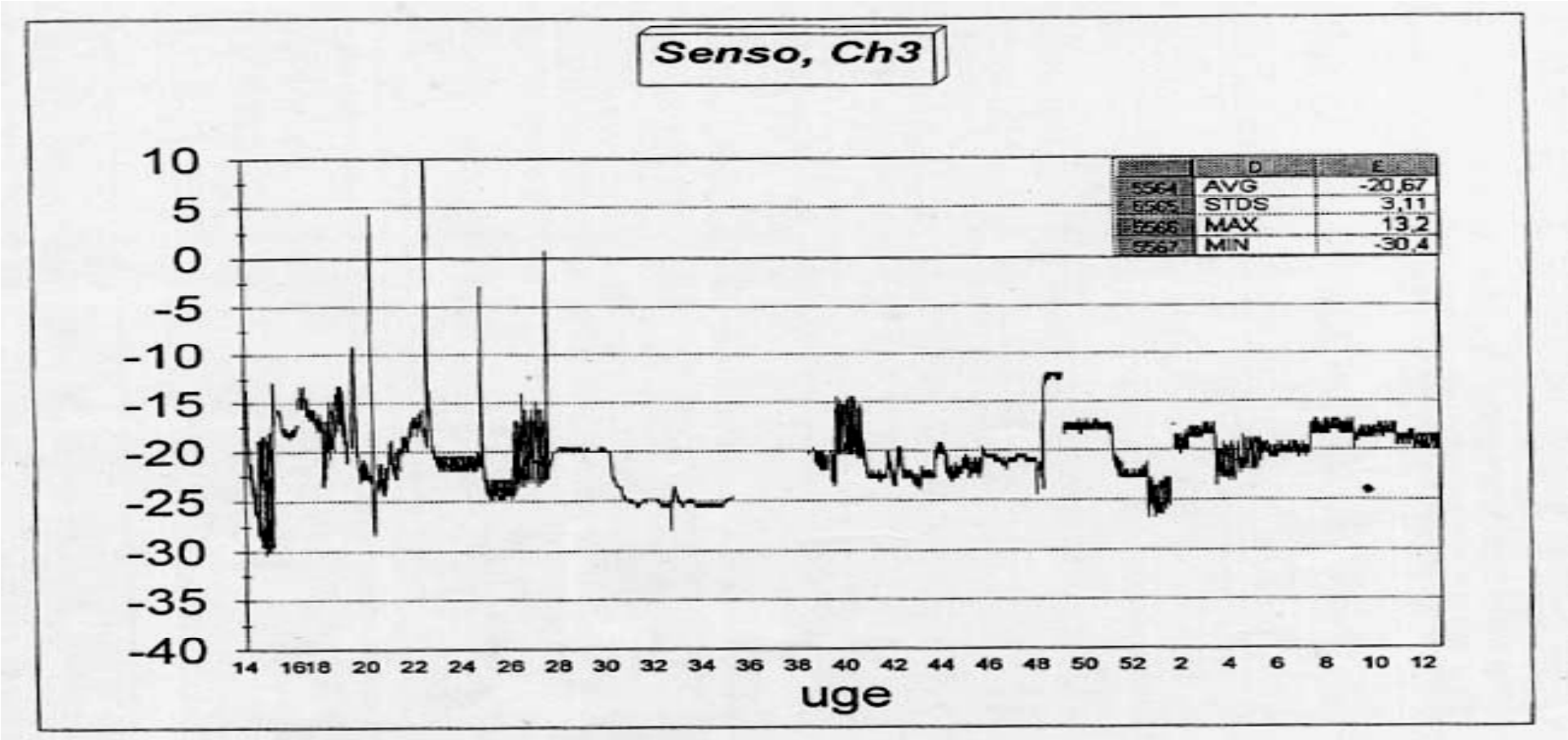
(Long, 1955)

Frysting - útjöfnun á hitastigi



Quality of Frozen Cold Water Shrimp

- *Study of Cold Water Shrimp stored in fluctuating temperature*
  - ✓ *Average -18 -20°C (fluctuation from -13°C - -26°C)*



E.M.Andersen, 1994

Quality of Frozen Cold Water Shrimp

- ***Sensory evaluation***
  Taste
  - ✓ *Rancid off flavor accelerates after 3 months in fluctuating temperature*
  - ✓ *No rancid off flavor after 12 months in stable temperature*

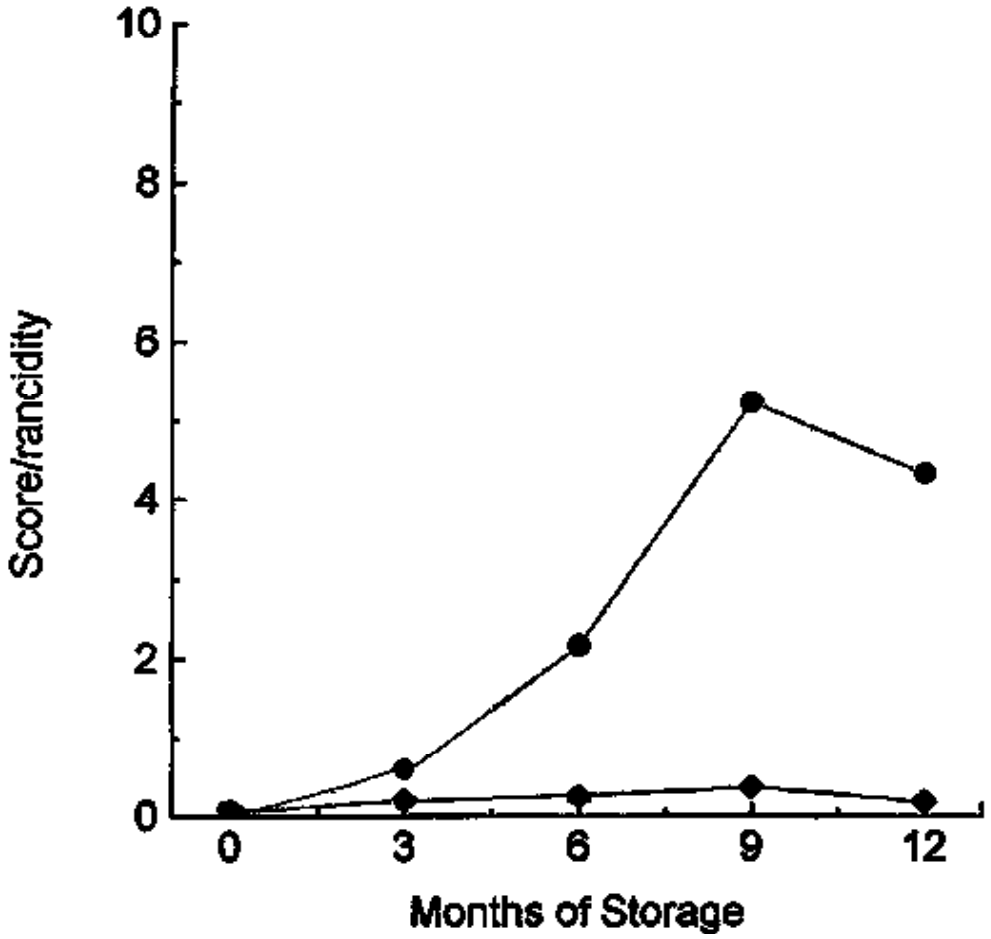


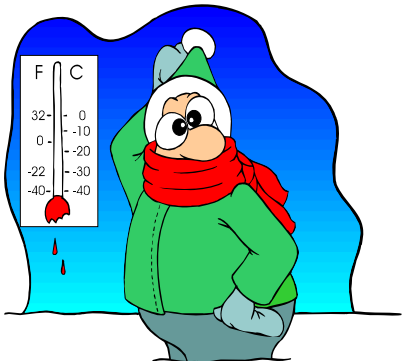
Fig.2b. Sensory scores for rancid flavour of shrimps packed in atmospheric air and stored in a freezer cabinet in darkness (•) or in a cold store in darkness (◆).

E.M.Andersen, 1994

Quality of Frozen Cold Water Shrimp

Chemical analysis, Lipid oxidation (rancidity)

- *starts from the very beginning in fluctuating temperature*
- *starts after 9-12 months at stable temperature*



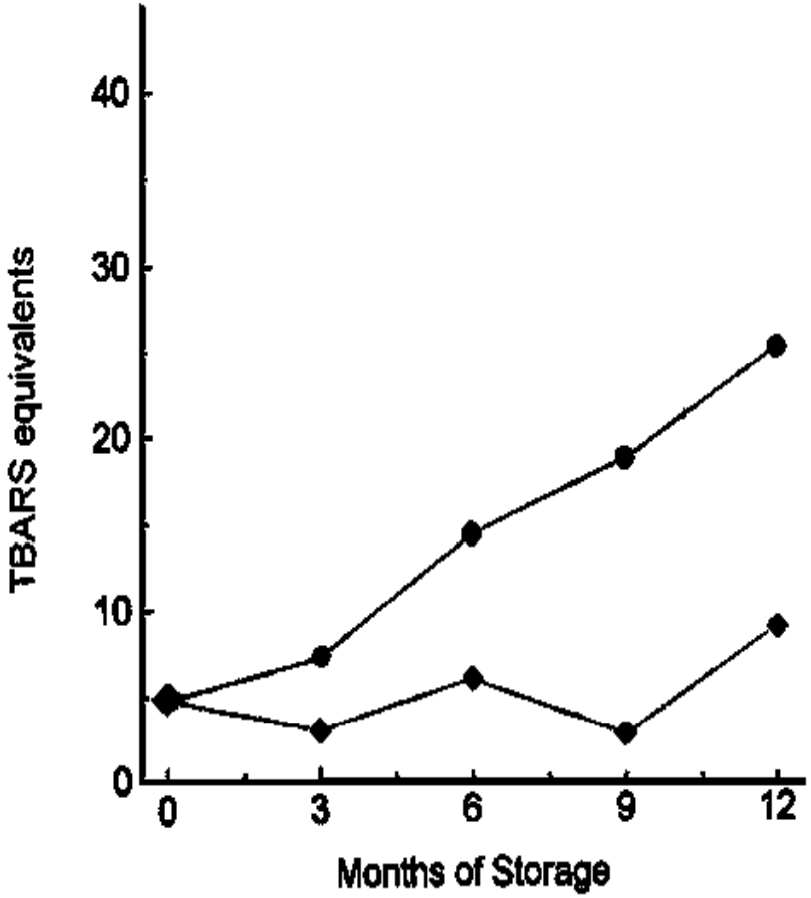


Fig.1b. Lipid oxidation measured by determination of TBARS (μmol/mg) of shrimps packed in atmospheric air and stored in a freezer cabinet in darkness (•) or in a cold store in darkness (♦).

Quality of Frozen Cold Water Shrimp

- ***Sensory evaluation Toughness***
  - ✓ ***increases from the very beginning in fluctuating temperature***
  - ✓ ***starts to increase after 9-12 months at stable temperature***

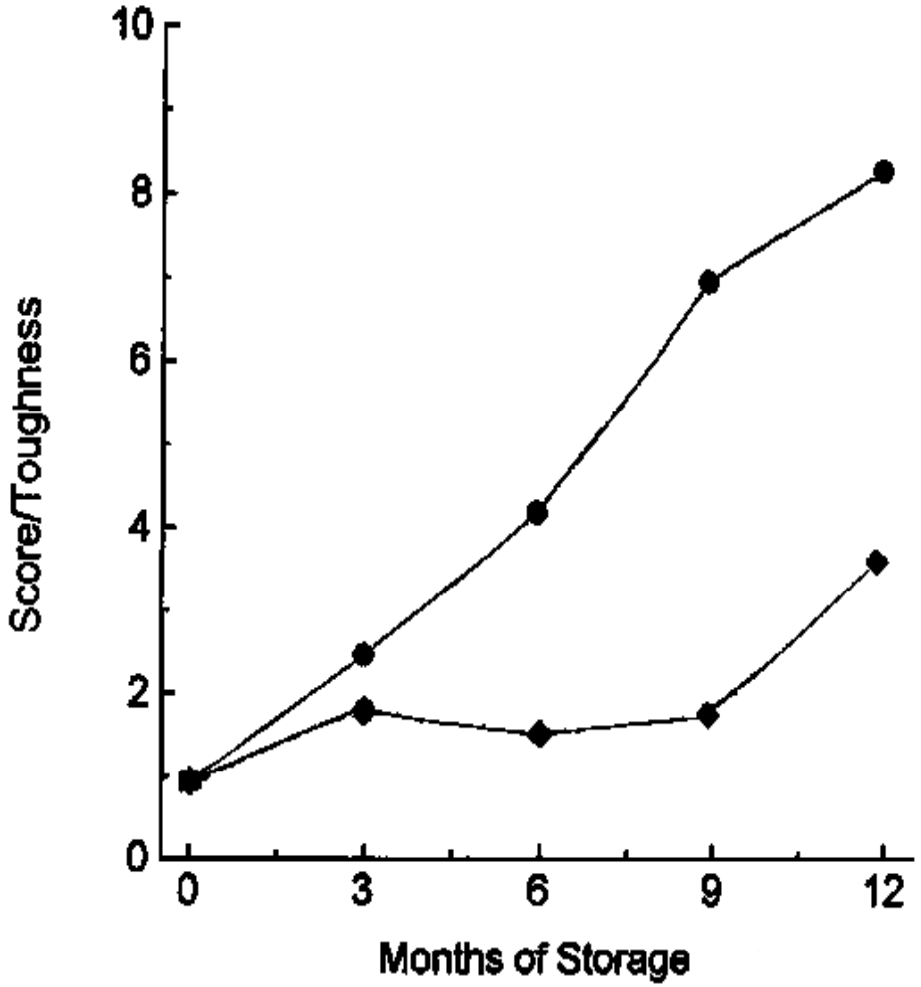


Fig.3b. Sensory scores for toughness of shrimps packed in atmospheric air and stored in a freezer cabinet in darkness (•) or in a cold store in darkness (◆). E.M.Andersen, 1994

Quality of Frozen Cold Water Shrimp

Light and fluctuating temperature in the retail market

- ***Color fades out already after 3 months***

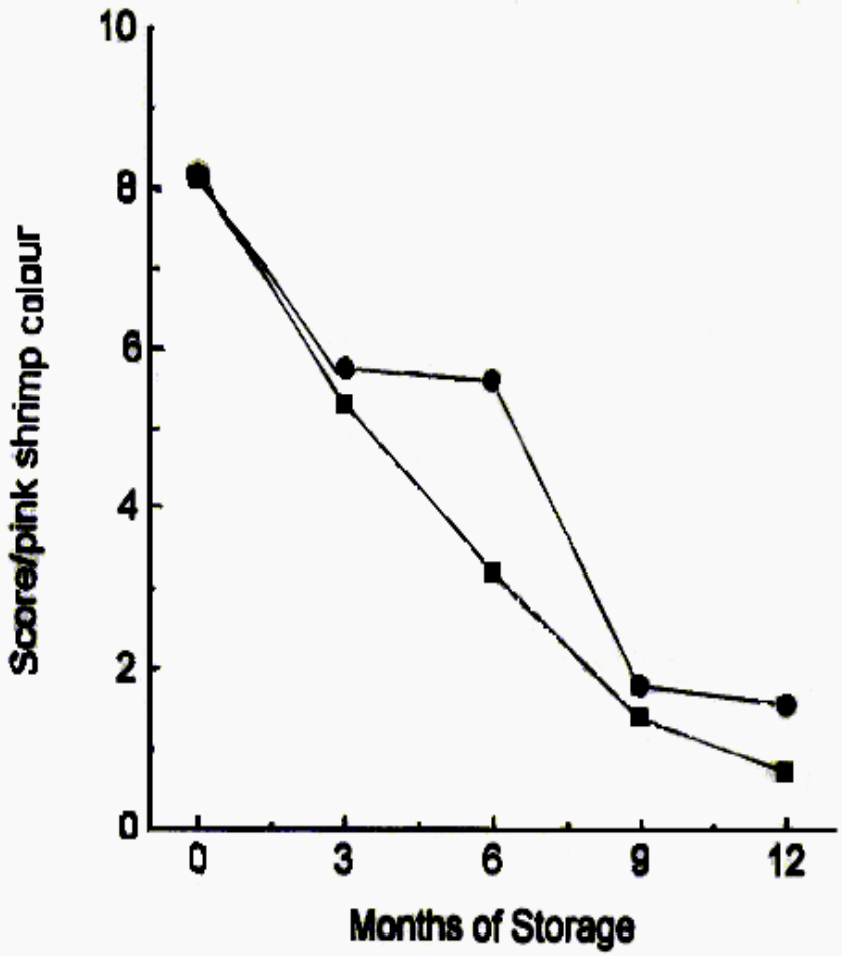


Fig.5a. Sensory scores for colour of shell-on shrimps packed in atmospheric air and stored in a freezer cabinet in light (■) or in darkness (•). E.M.Andersen, 1994

Quality of Frozen Cold Water Shrimp

- ***Light and fluctuating temperature in the retail market***
  - ✓ ***Development of toughness accelerates significant after 3 months***

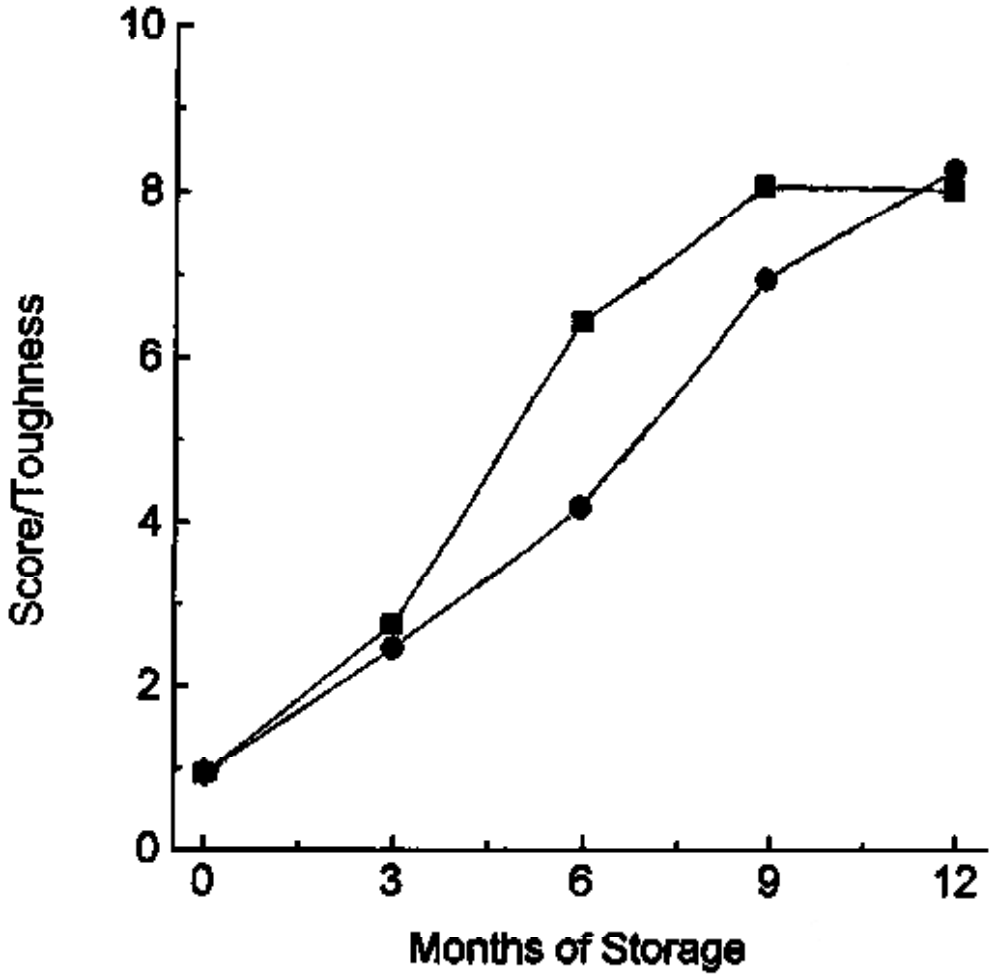


Fig.3a. Sensory scores for toughness of shrimps packed in atmospheric air and stored in a freezer cabinet in light (■) or in darkness (•). E.M.Andersen, 1994

Quality of Frozen Cold Water Shrimp

- ***Light and fluctuating temperature in the retail market***
  - ✓ ***Development of rancid off flavor accelerates significant after 3 months***

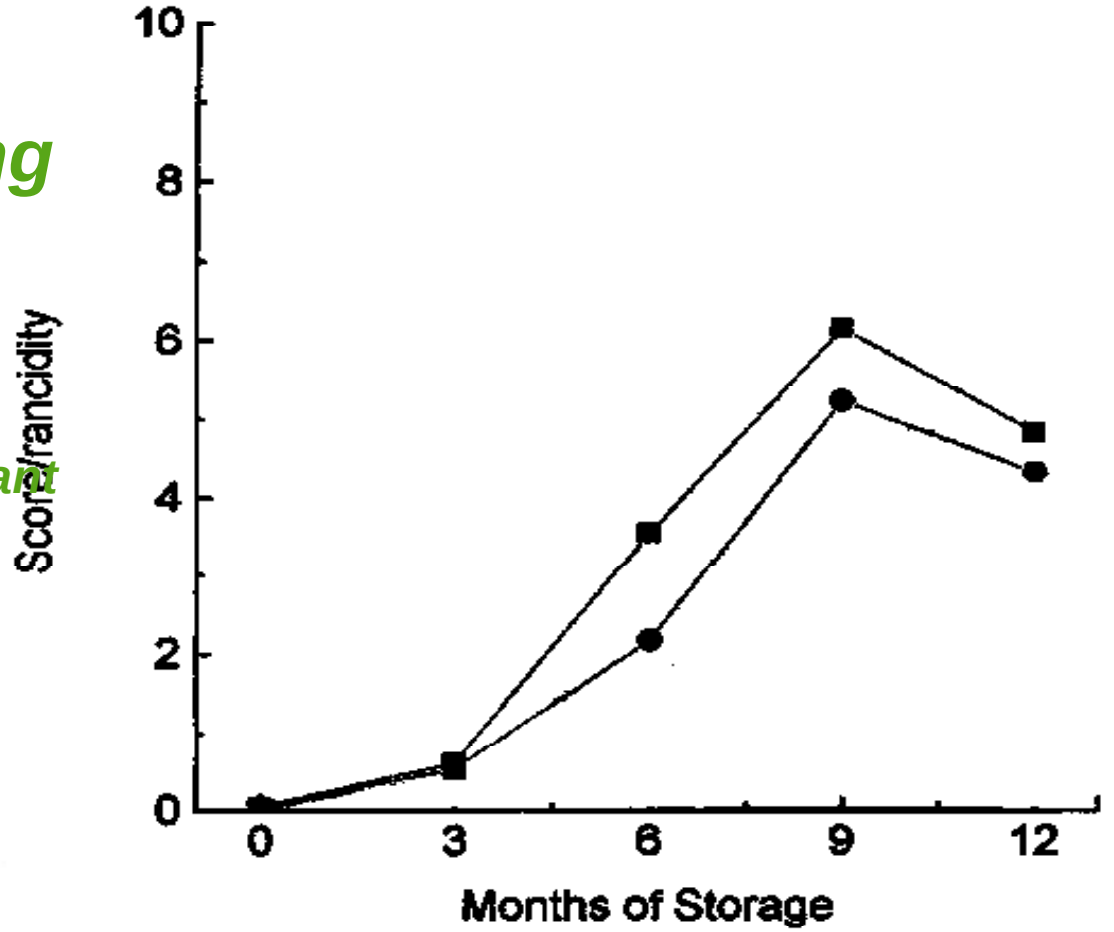


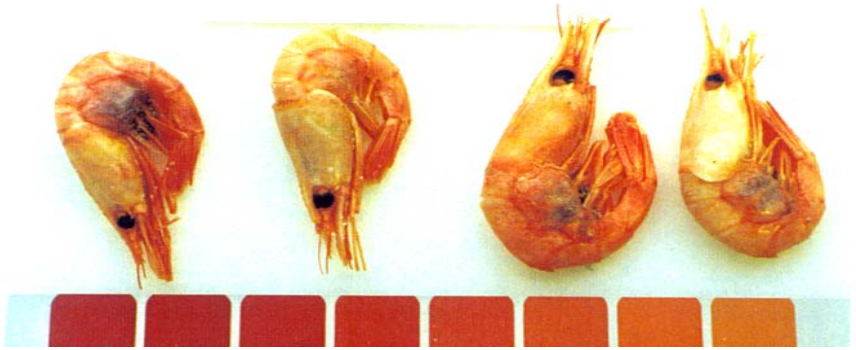
Fig.2a. Sensory scores for rancid flavour of shrimps packed in atmospheric air and stored in a freezer cabinet in light (■) or in darkness (•).

Quality of Frozen Cold Water Shrimp

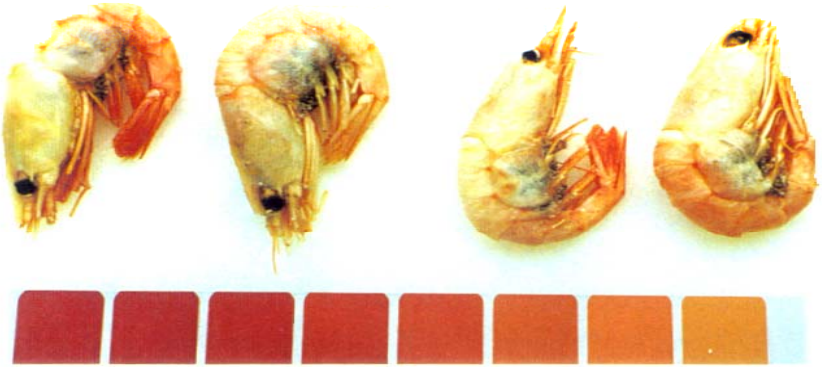
Appearance of Cooked, IQF, HOSO coldwater shrimp after 12 months in cold storage 18±7 C in light 18±7 C in darkness

Code 7
12 months

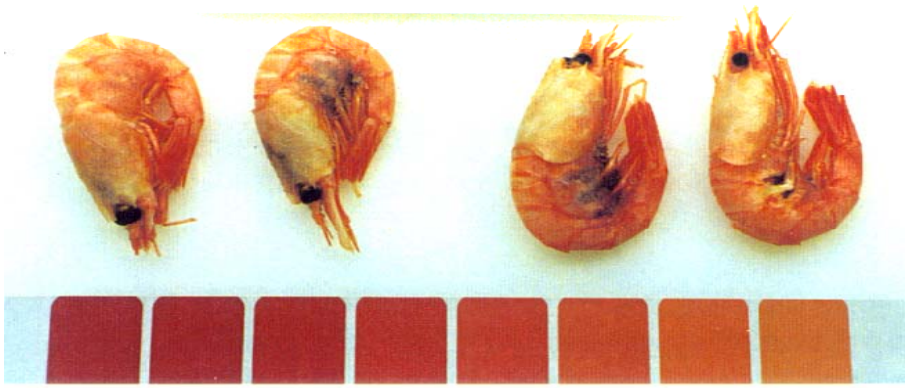
Code 8
12 months



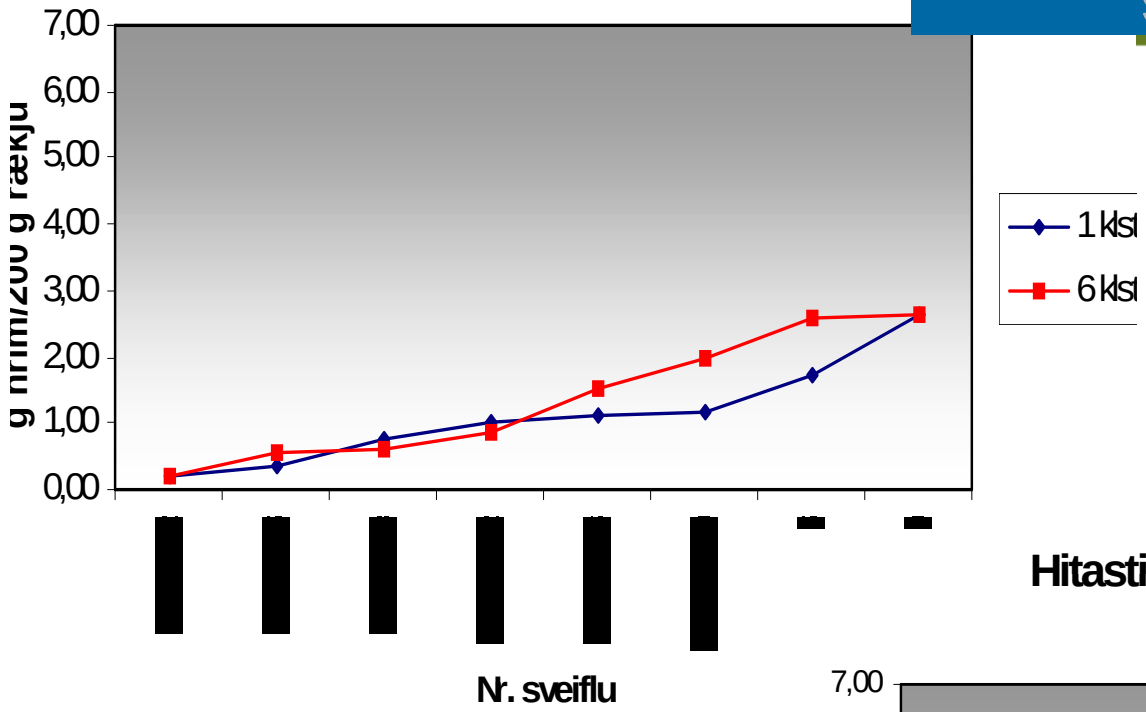
Code 3
12 months

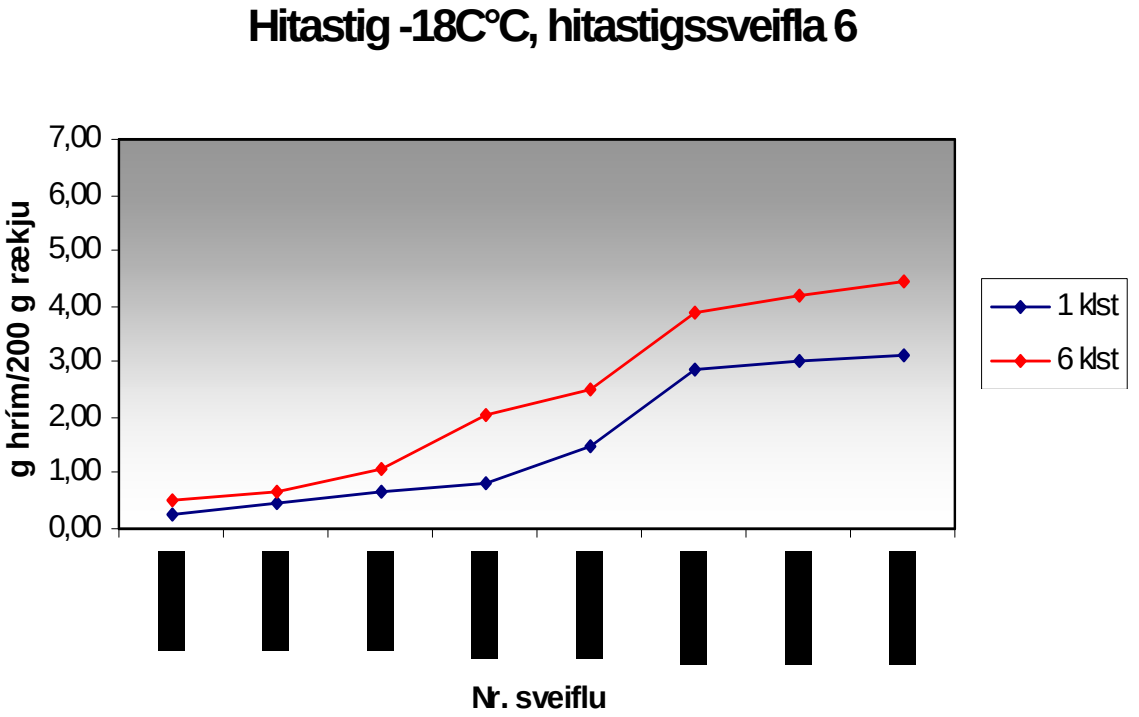


Code 4
12 months



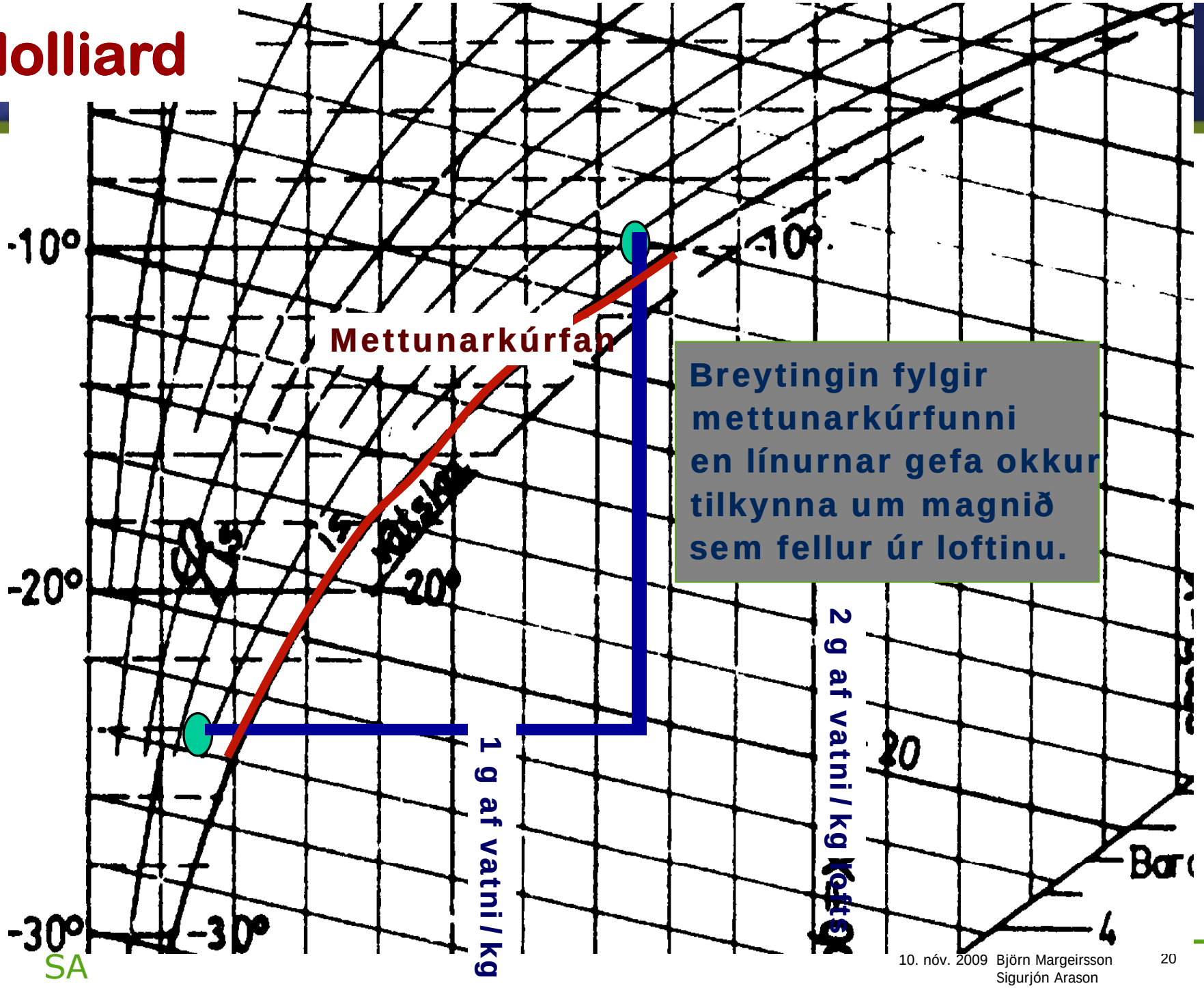
Áhrif hitasveifla á hrím við geymslu á Rækja



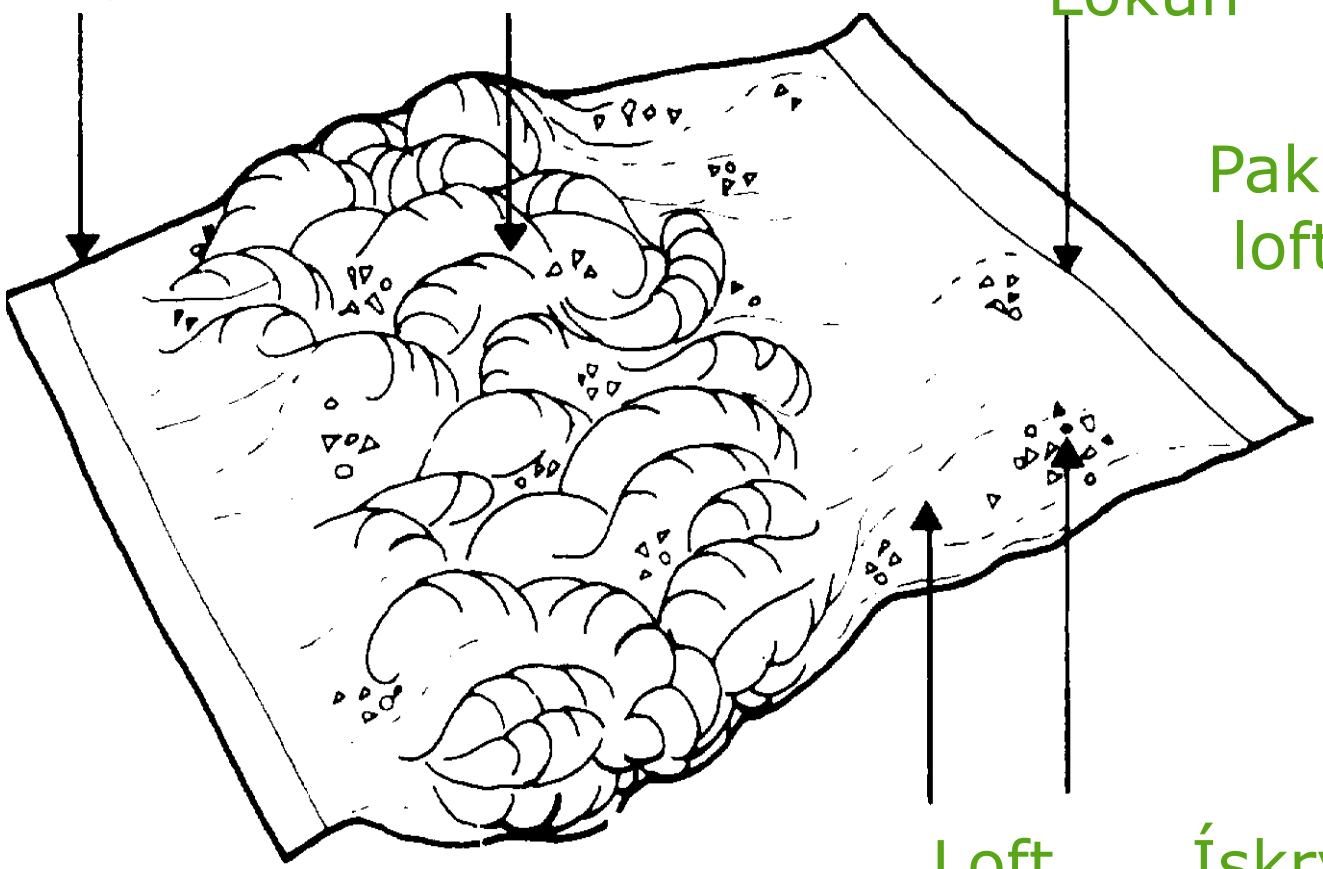


(K.Axelsdóttir, 2002)

Molliard


-10°
-20°
-30°
-10°
-30°
20
20
Mettunarkúrfan
Breytingin fylgir mettunarkúrfunni en línurnar gefa okkur tilkynna um magnið sem fellur úr loftinu.
1 g af vatni / kg
2 g af vatni / kg lofts
4

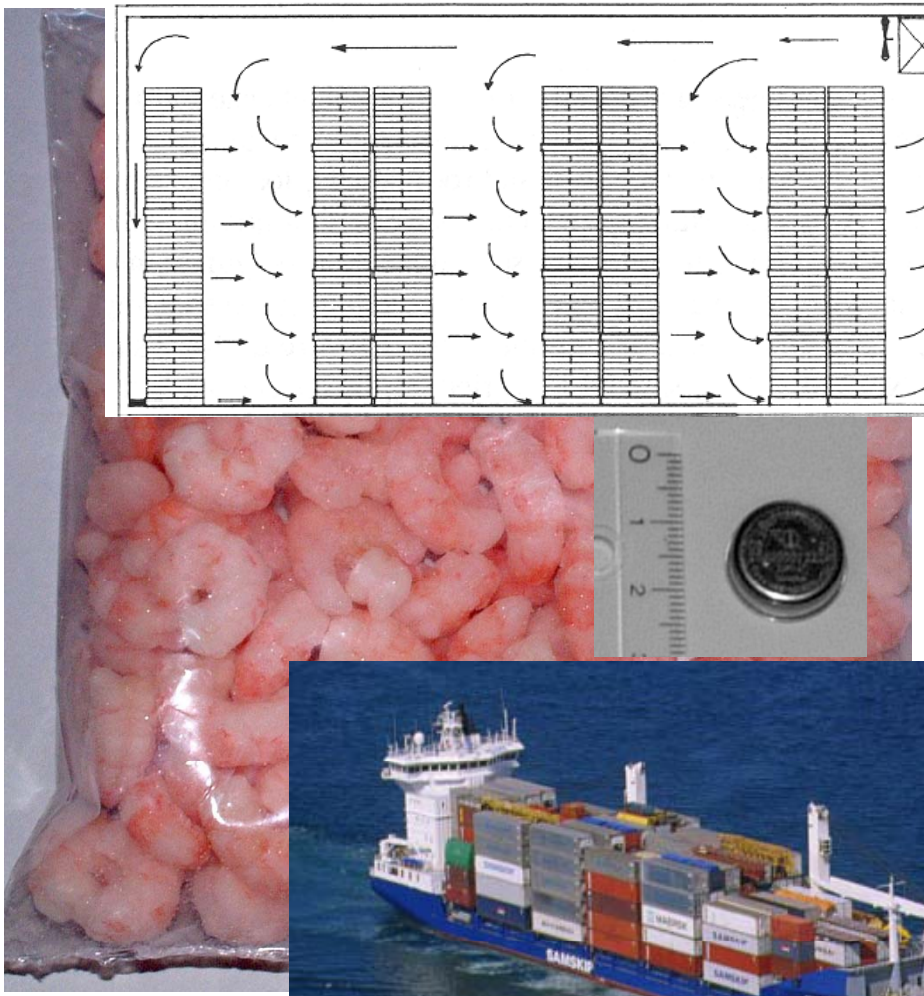
Pökkuð, pilluð rækja í plastpoka.



(Petersen 1989)

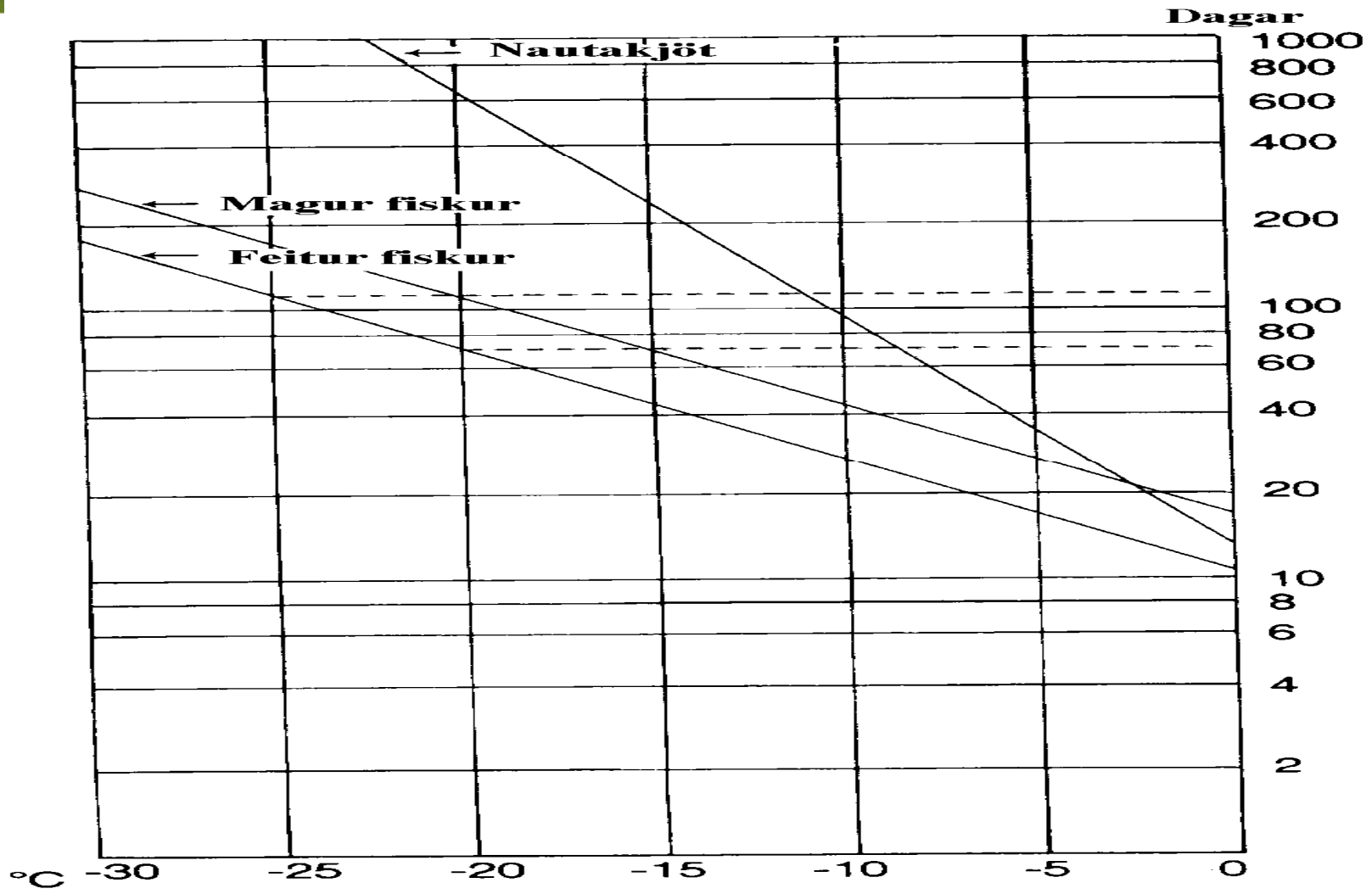
IQF frozen shrimp

Ice cristals?



Duct openings of a refrigeration unit with significant rime

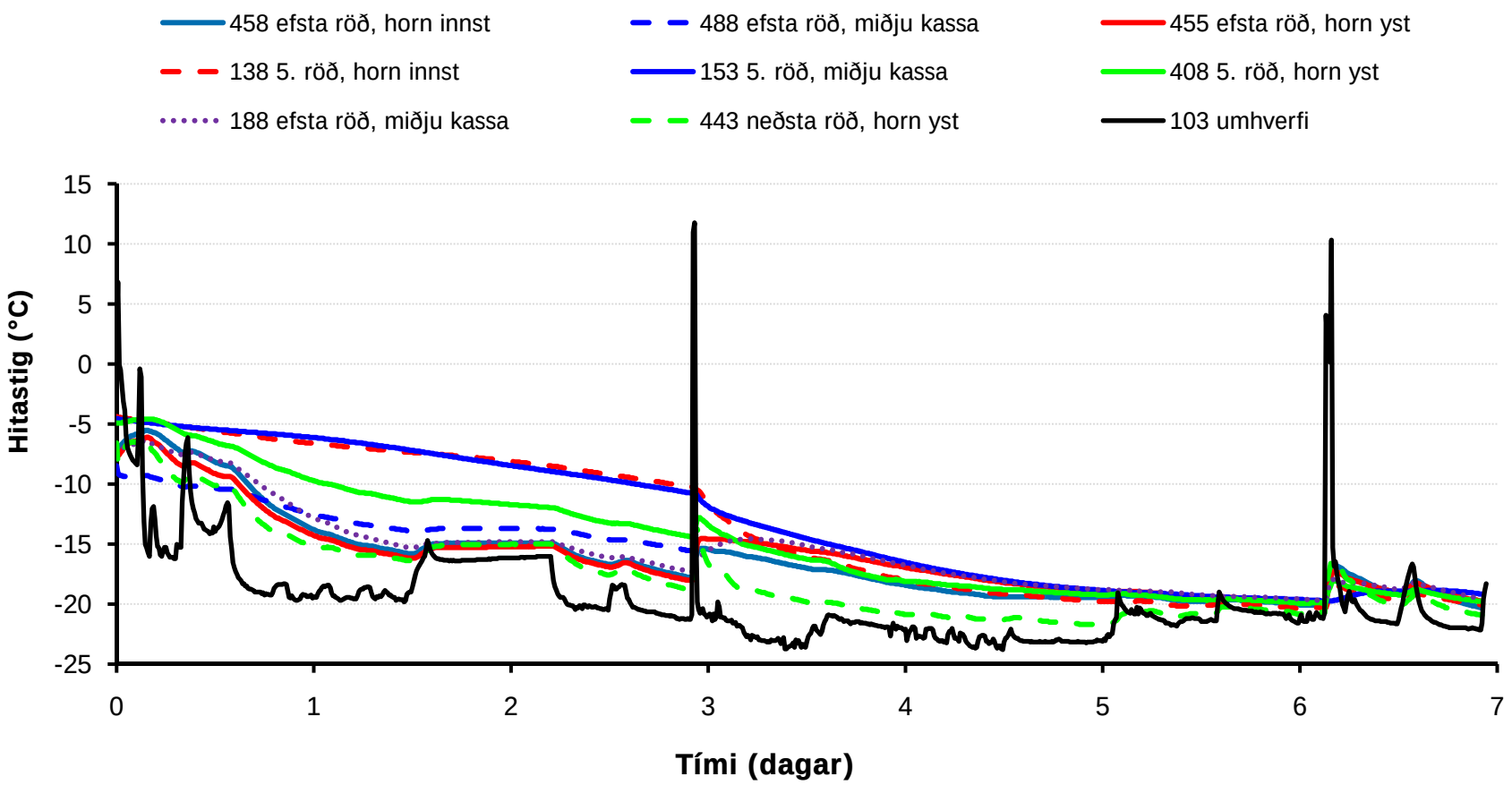
Gæðarýrnun frosins fisks



Pedersen, 1989

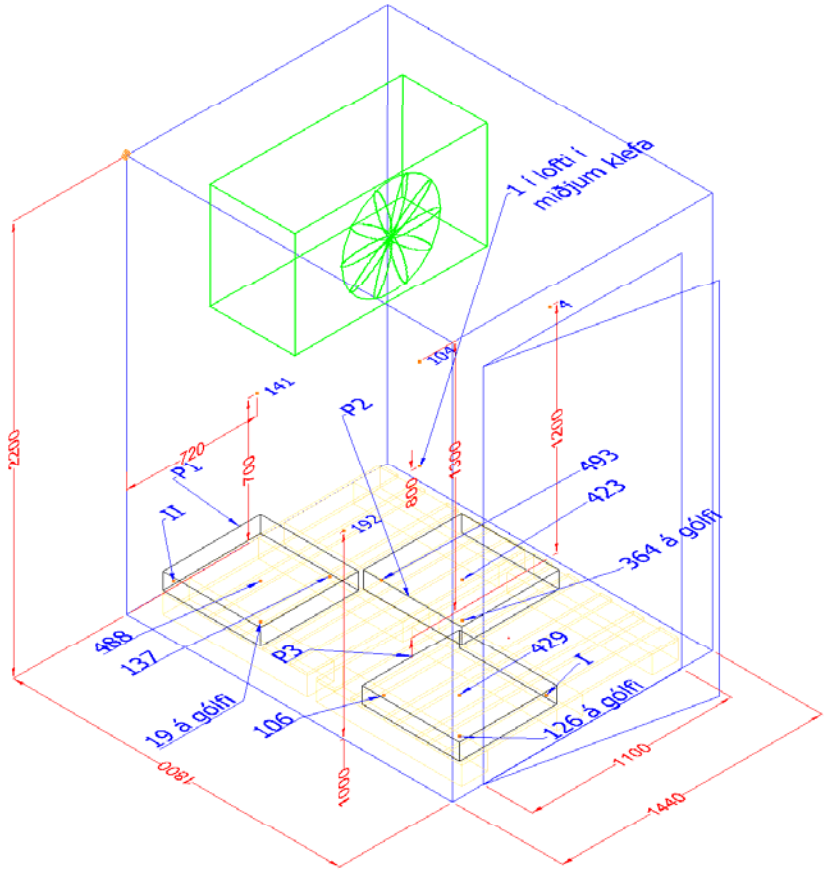
Frysting hálffrosinnar grálúðu í frostgeymslu

Frysting hálffrosinnar grálúðu í frostgeymslu



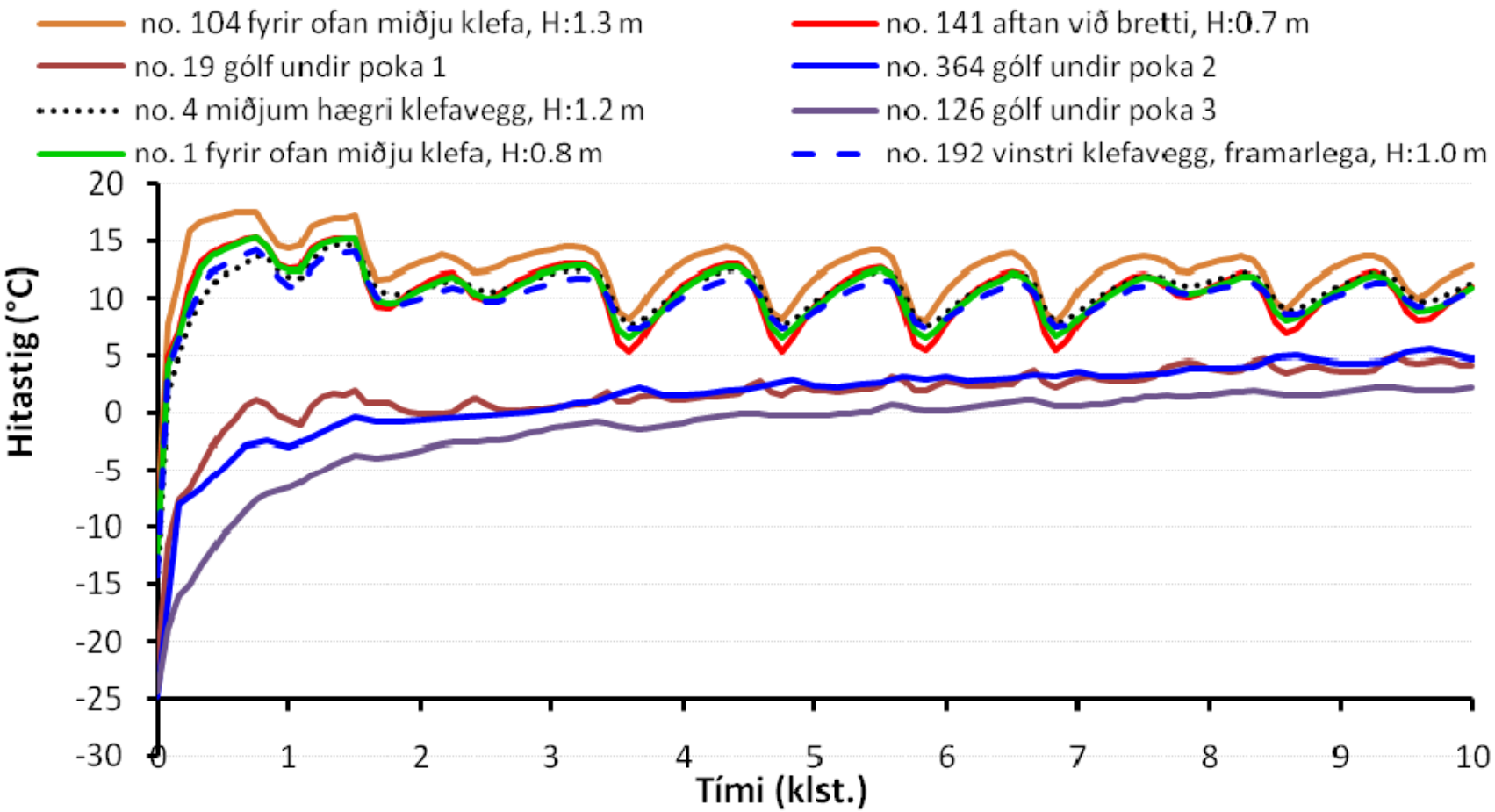
<u>Upphafshiti grálúðu milli -10 og -5 °C</u>
1. Mjög ójöfn hitadreifing á brettinu
2. Tók allt að fjóra daga að frysta allt brettið niður fyrir -15 °C

Þíðing stakra grálúðupoka

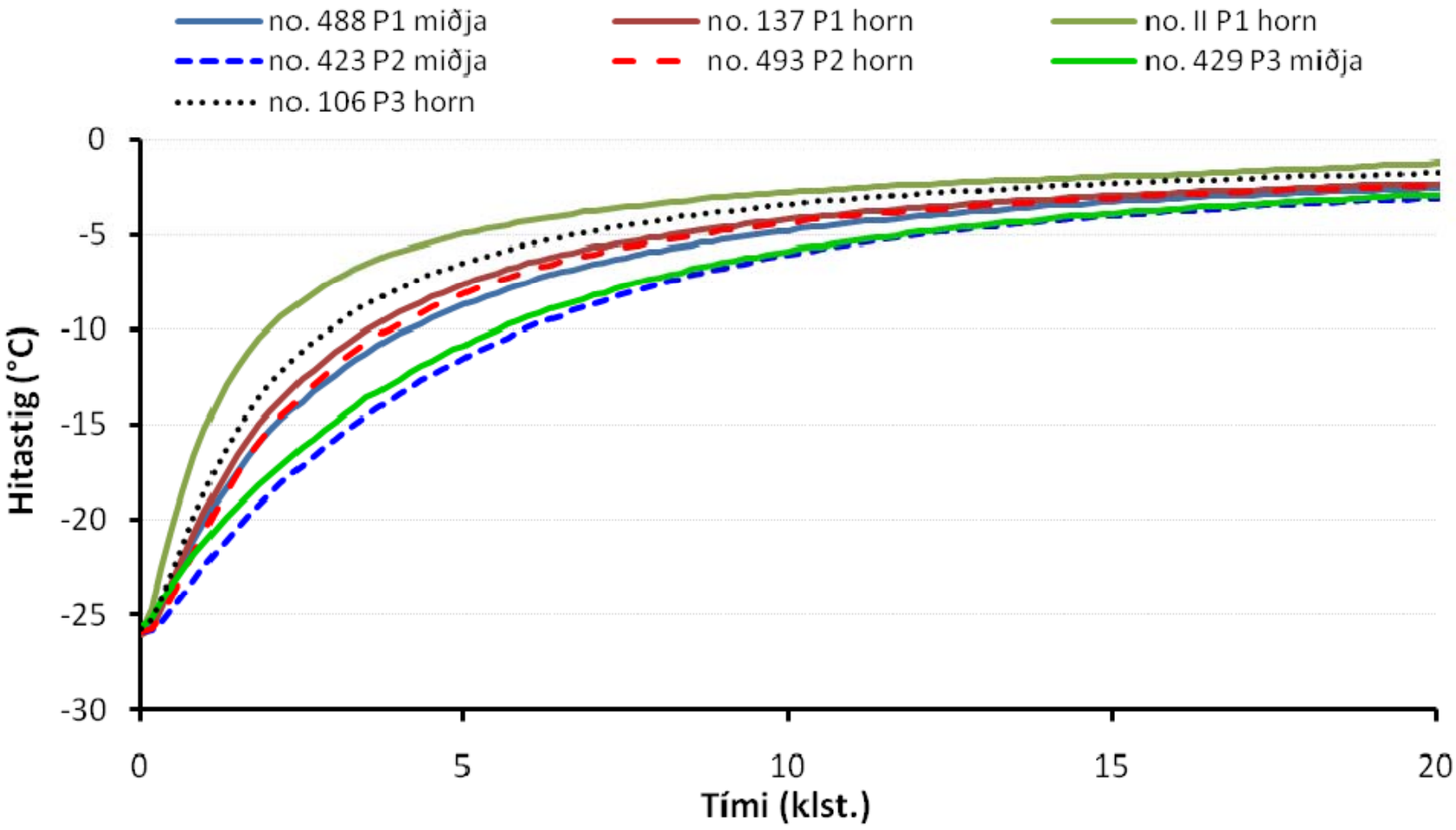


<u>Uppsetning tilraunar:</u>
Fylgst með hitaþróun í 8 staðsetningum í 3 stökum grálúðupokum sem verða fyrir hitaálagi í klefa

Þíðing stakra grálúðupoka - umhverfishiti



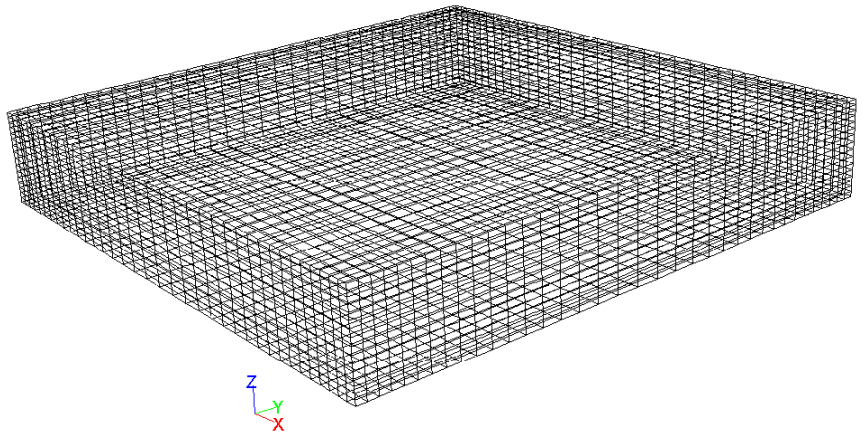
Þíðing stakra grálúðupoka - vöruhiti



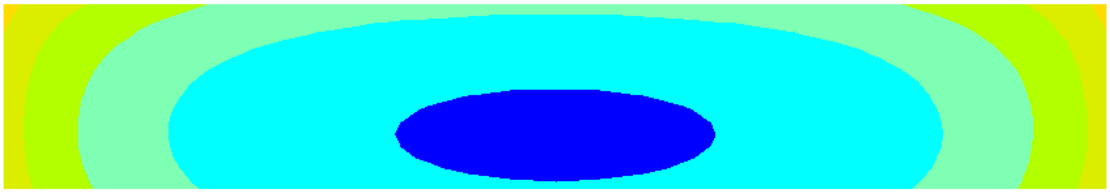
<u>Niðurstöður</u>: mikill hitamunur milli miðju og hornpkt. enda mikið varmaviðnám fólgið í vörunni sjálfri

CFD varmaflutningslíkan af stökum grálúðupoka

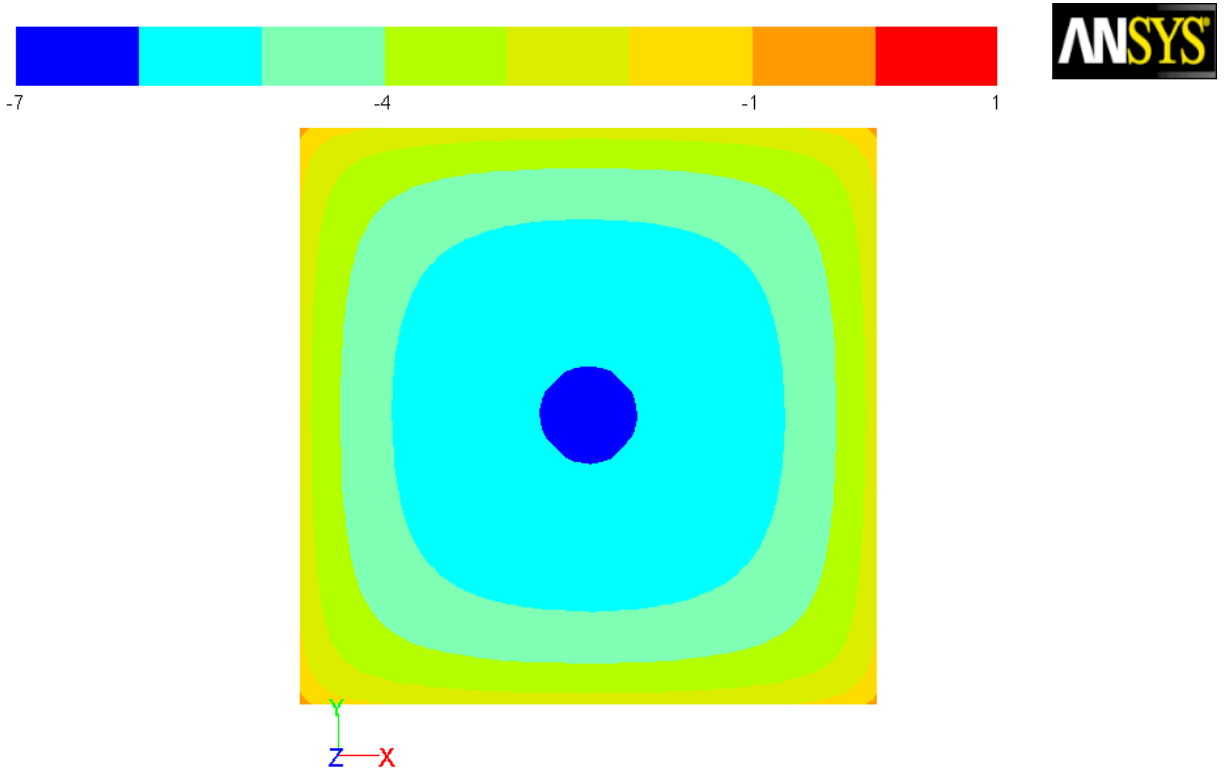
- **Smíðað í ANSYS-FLUENT**
- **Kassalaga poki (54 x 54 x 10 cm) byggður upp af 20.736 reiknieiningum**
- **Upphafshiti -26.0 °C sbr. tilraun**
- **Jaðarskilyrði: áætlaður varmaburðarstuðull fyrir topp, botn og hliðar og umhverfishiti úr tilraun notaður sem umhverfishiti**
- **Varmafræðilegir eiginleikar þorsks notaðir þar sem þeir eru mjög vel þekktir og varmaleiðni og eðlisvarmi prótíns og fitu eru mjög áþekk**
- **Varmaflæði og hitadreifing hermd í 10 klst. með 1 mín tímaskrefstærð – keyrslan tók u.þ.b. 20 mín**



Niðurstöður líkans eftir 10 klst. hitaálag (12.6 °C)

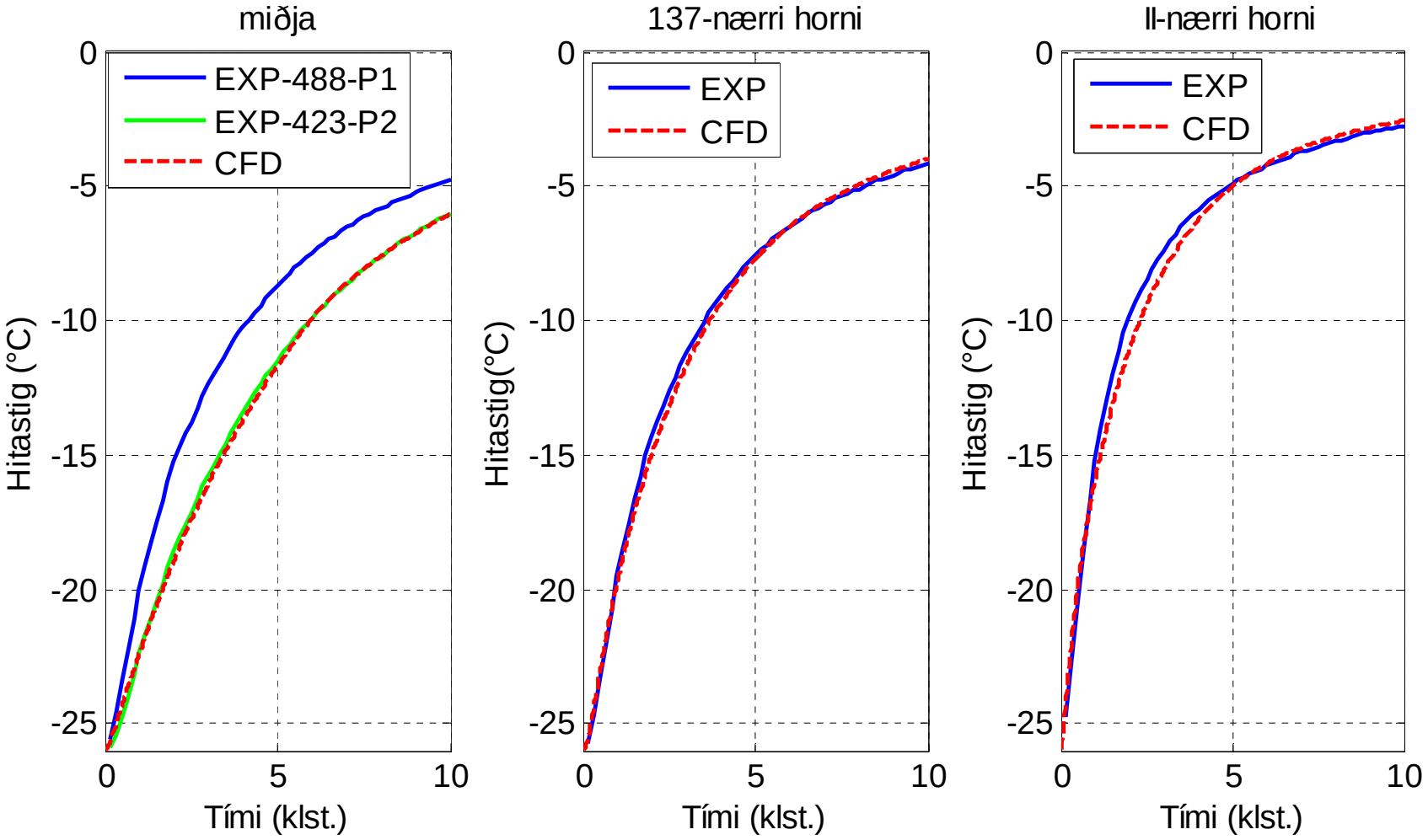


Hitadreifing (°C) í lóðréttu sniði í miðju poka

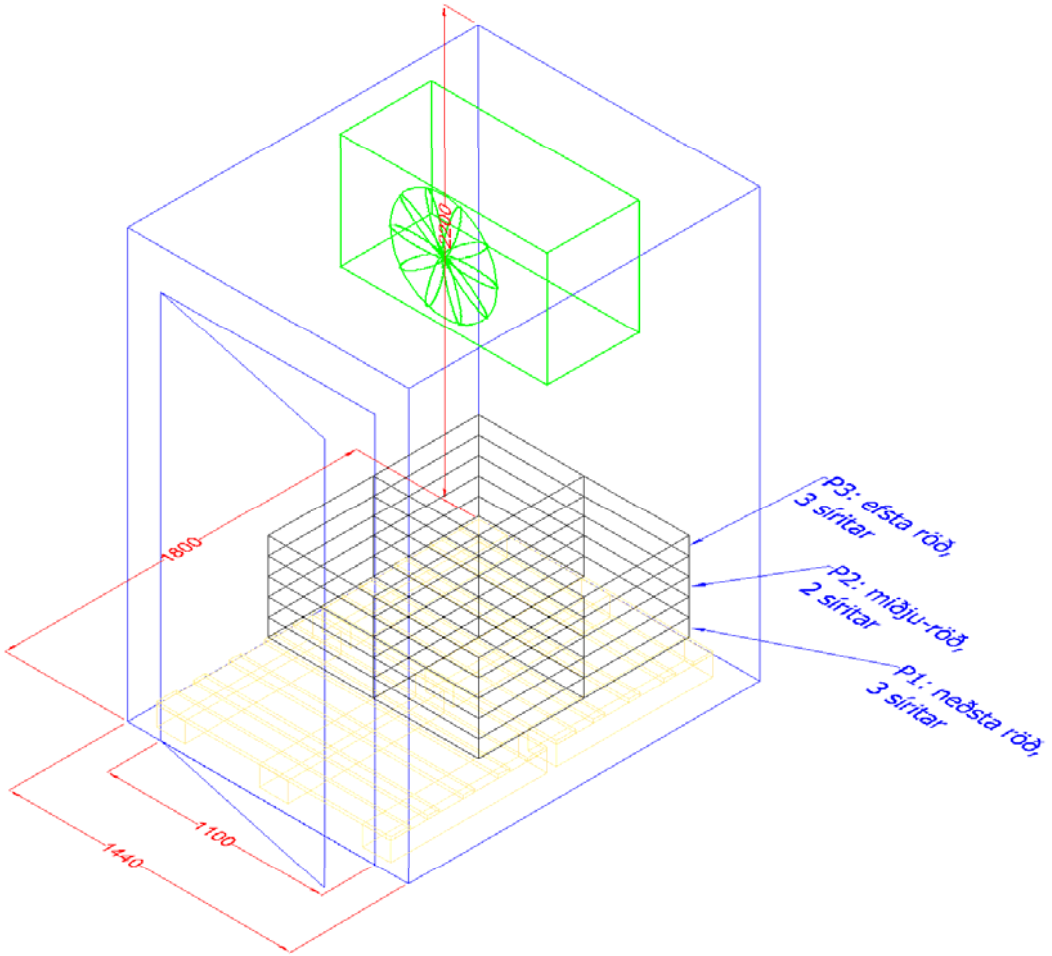


Hitadreifing (°C) í láréttu sniði í miðju poka

Samanburður líkans og tilraunar fyrir stakan grálúðupoka

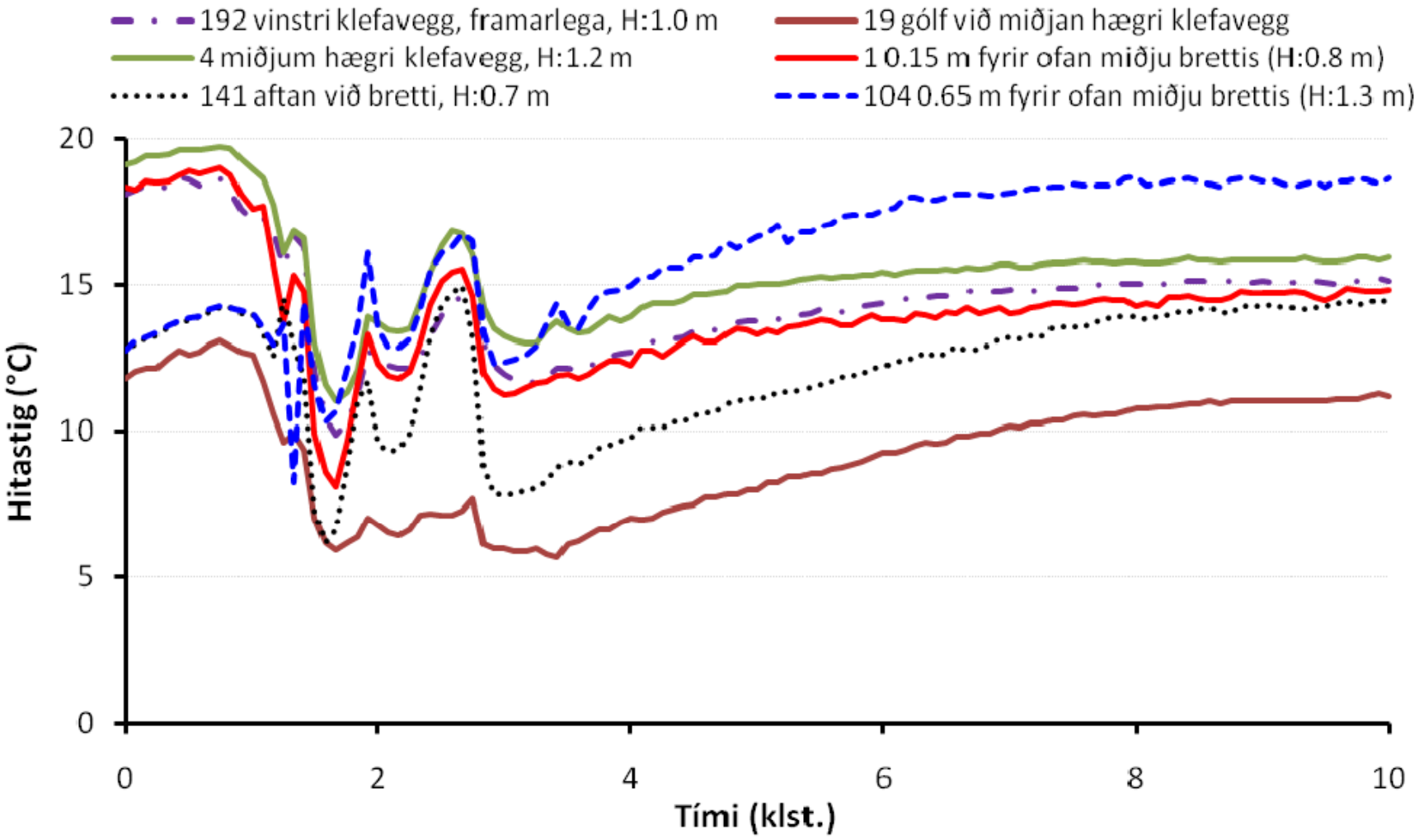


Þíðing 20 grálúðupoka á bretti

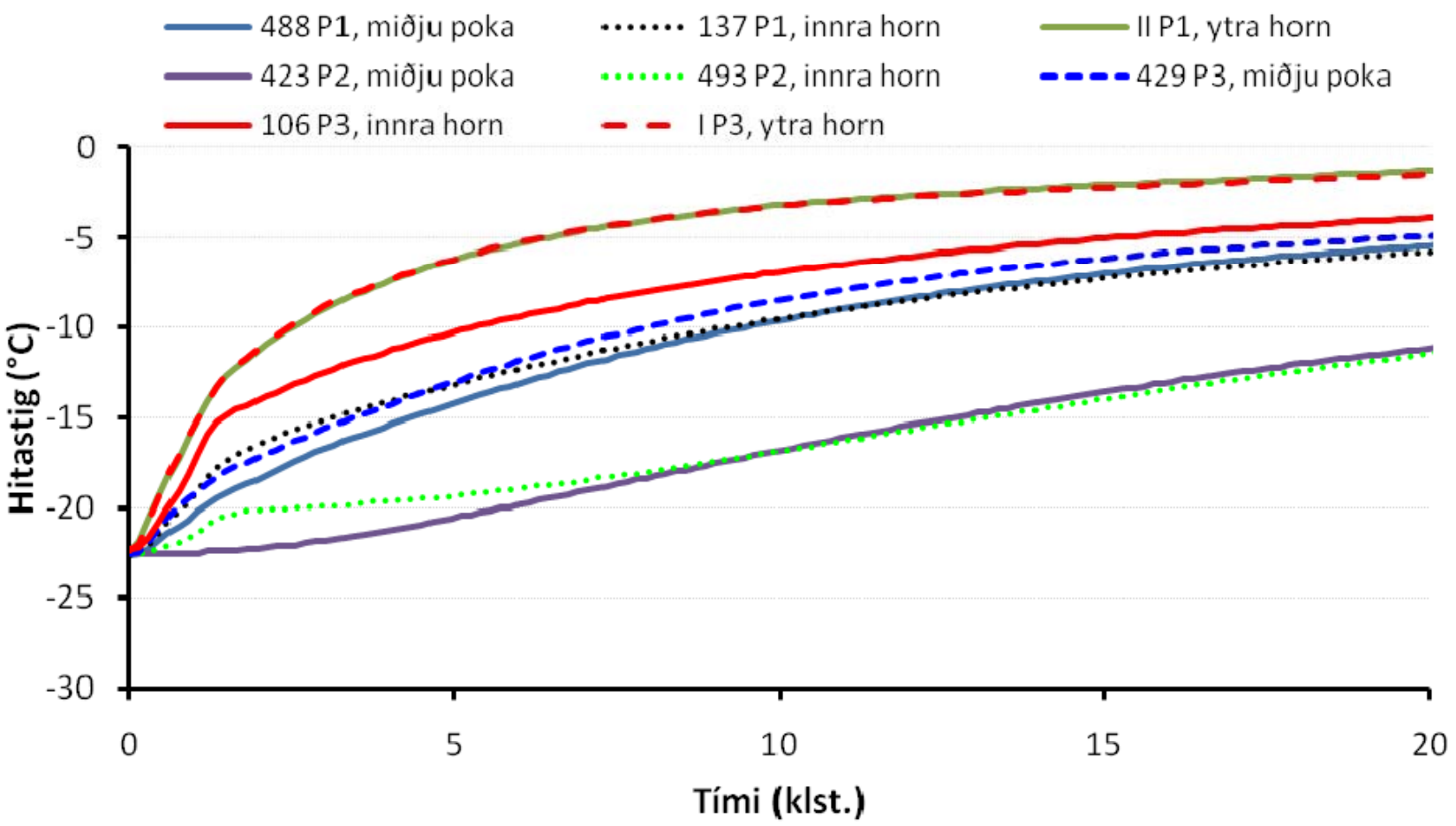


<u>Uppsetning tilraunar:</u>
Fylgst með hitaþróun í 8 staðsetningum í 3 stökum grálúðupokum sem verða fyrir hitaálagi í klefa

Þíðing 20 grálúðupoka - umhverfishiti



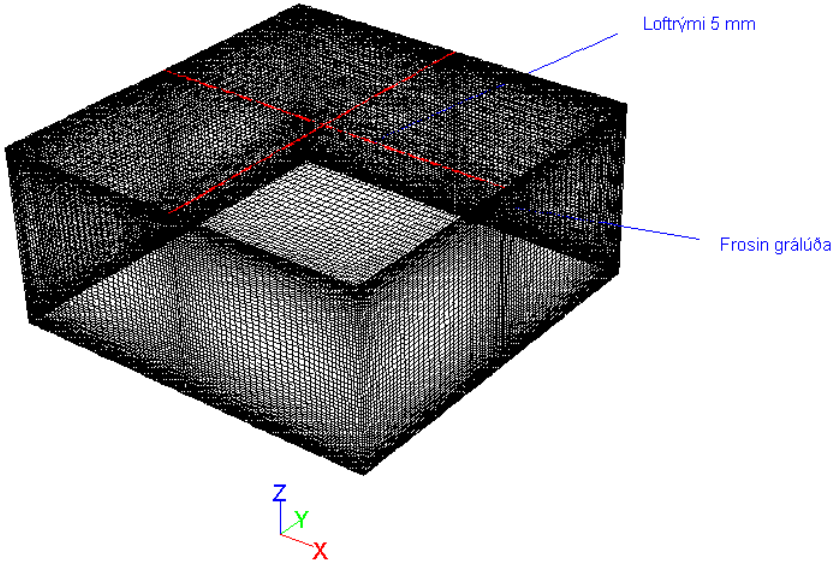
Þíðing stakra grálúðupoka - vöruhiti



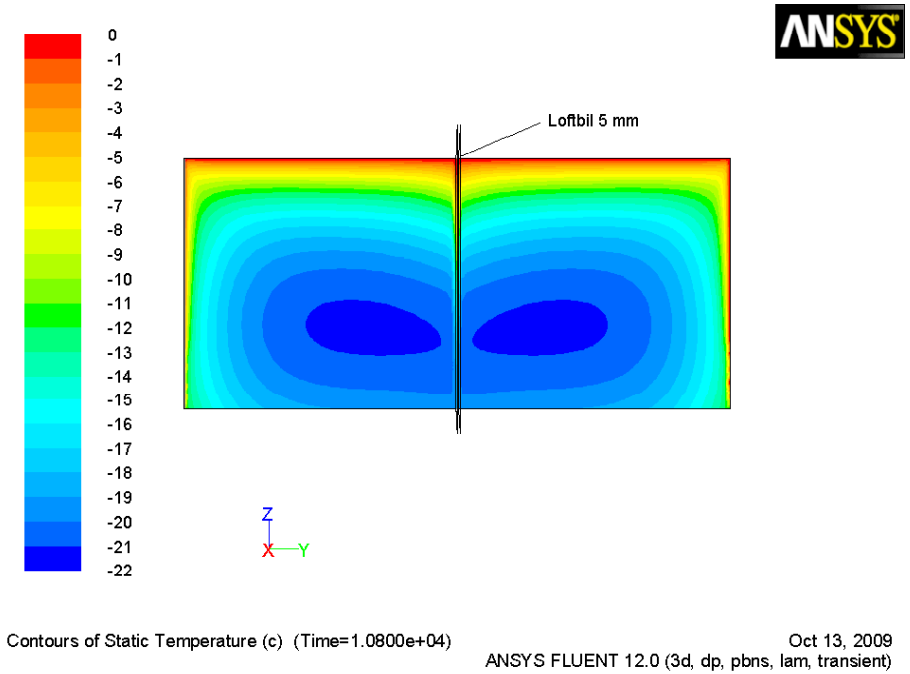
<u>Niðurstöður</u>: mikill hitamunur milli miðju og hornpkt. annars vegar og milli pokanna hins vegar

CFD varmaflutningslíkan af heilu bretti af grálúðu

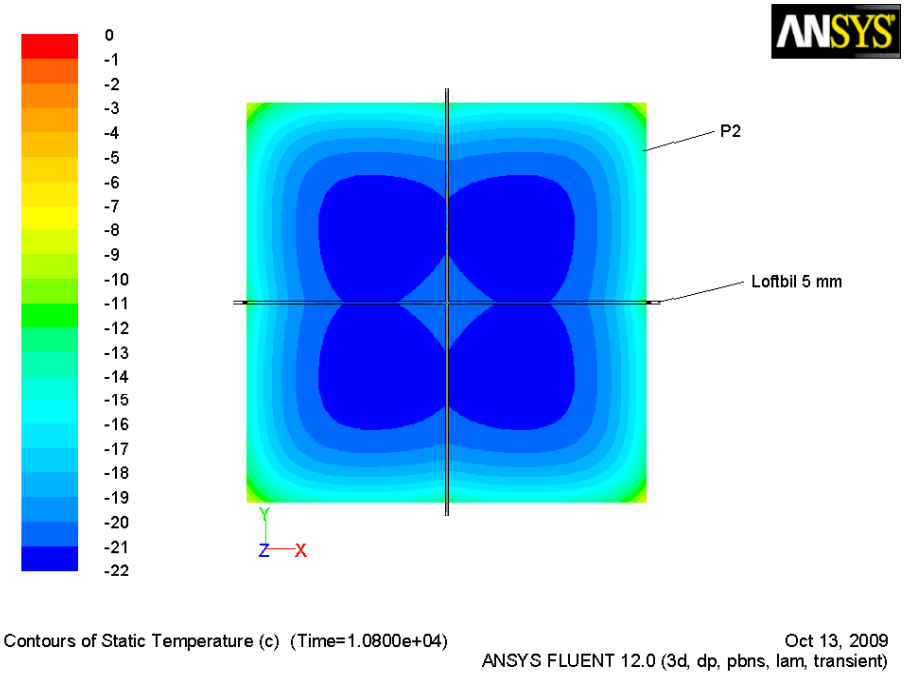
- **Smíðað í ANSYS-FLUENT**
- **20 kassalaga pokar (54 x 54 x 10 cm) byggt upp af 578 þús. reiknieiningum**
- **Upphafshiti -22.5 °C sbr. tilraun**
- **Jaðarskilyrði: áætlaður varmaburðarstuðull fyrir topp, botn og hliðar og umhverfishiti úr tilraun notaður sem umhverfishiti**
- **5 mm lóðrétt loftbil til að taka með í reikninginn að pokar staflast ekki fullkomlega saman**
- **Varmafræðilegir eiginleikar þorsks**
- **Varmaflæði og hitadreifing hermd í 10 klst. með 1 mín tímaskrefstærð – keyrslan tók nokkrar klst.**



Niðurstöður líkans fyrir 20 poka eftir 3 klst. hitaálag

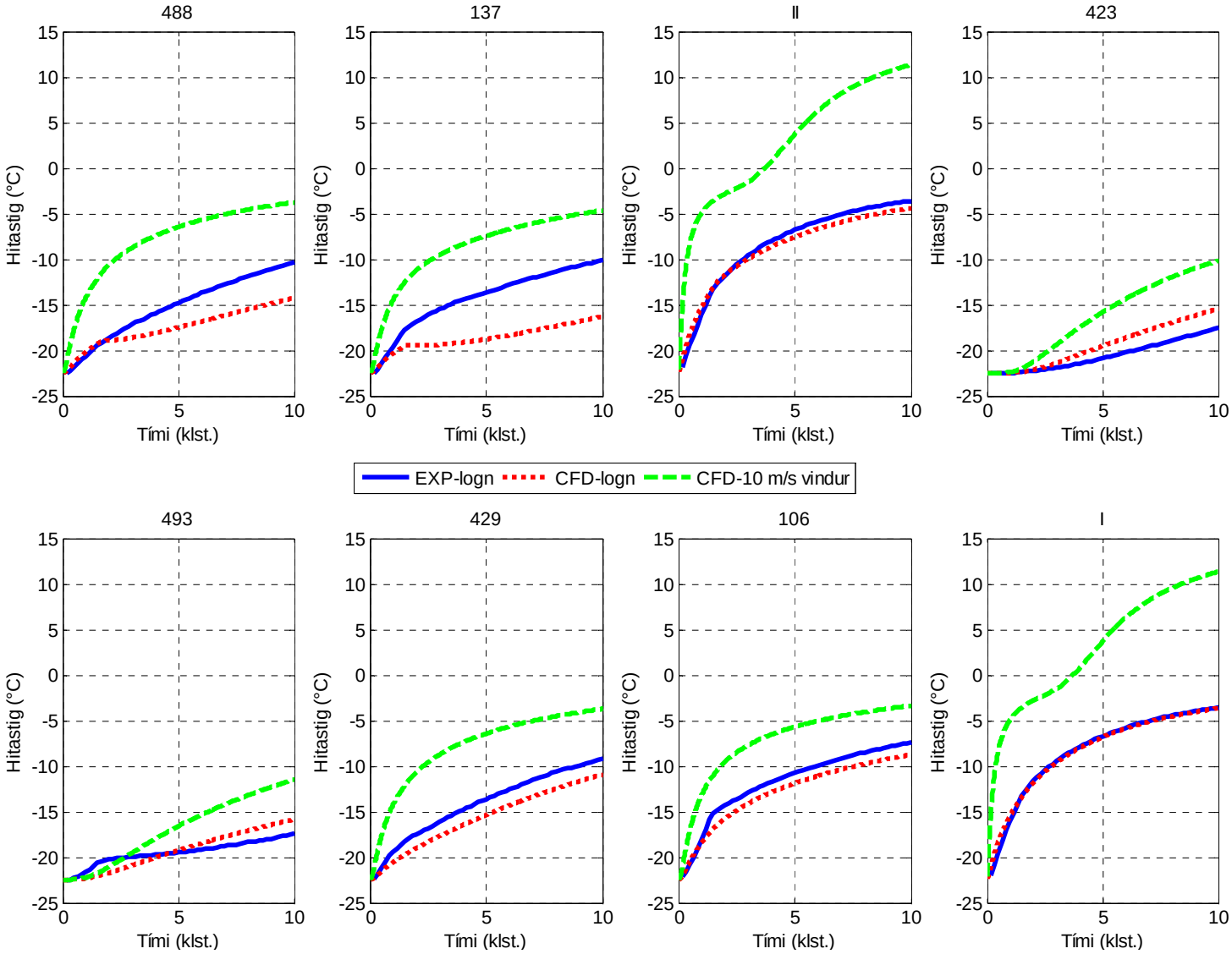


Hitadreifing (°C) í lóðréttu sniði í miðju stafla



Hitadreifing (°C) í láréttu sniði í miðri hæð stafla

Samanburður líkans og tilraunar fyrir 20 poka og áhrif 10 m/s vinds (eðlilegt t.d. við löndun)



Samantekt

- **Frysting hálffrystrar vöru getur hæglega tekið 4 daga í frostgeymslu**
  - **frostgeymslur eru til að viðhalda vöru frosinni, ekki frysta vöruna!**
- **Stakir pokar þiðnuðu úr -26 °C í u.þ.b. -12 til -5 °C á einungis 5 klst. við 12-13 °C umhverfishita**
  - **ath. mjög óeinsleita hitadreifingu í pokum**
- **Mjög góð samsvörun fékkst milli niðurstaðna CFD líkans og tilrauna fyrir staka poka, lakari fyrir heil bretti (ath. óvissu um þéttleika og óreglulega lögun poka á bretti)**

- **Hiti í 20 pokum á bretti hækkaði úr -22.5 °C í u.þ.b. -21 til -6 °C á 5 klst. við 16-18 °C umhverfishita**
  - **ath. mjög óeinsleita hitadreifingu í pokum og milli poka**

- **Áhrif vinds mjög marktækt neikvæð**