SHTE Swedish Suppliers of Heat Treatment Equipment

Värmebehandlingskonferensen, 9 – 10 oktober 2019
på Louis De Geer Konferens i Norrköping

Ipsen

Low Pressure Carburizing and Corresponding Furnace Solutions

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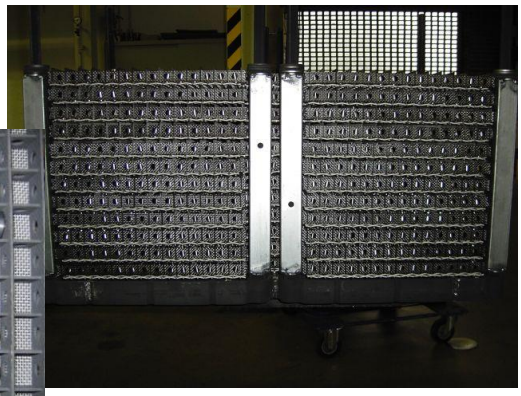
Industrial Load with 900 Nozzles

Ipsen

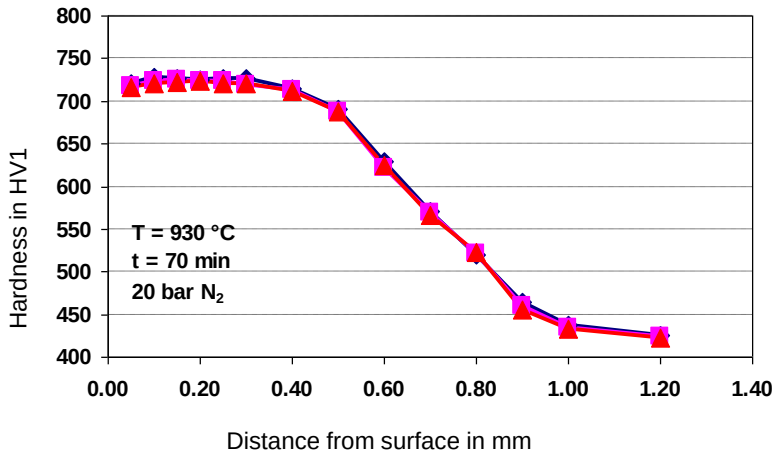
Industrial load with 10200 “Nozzle bodies”



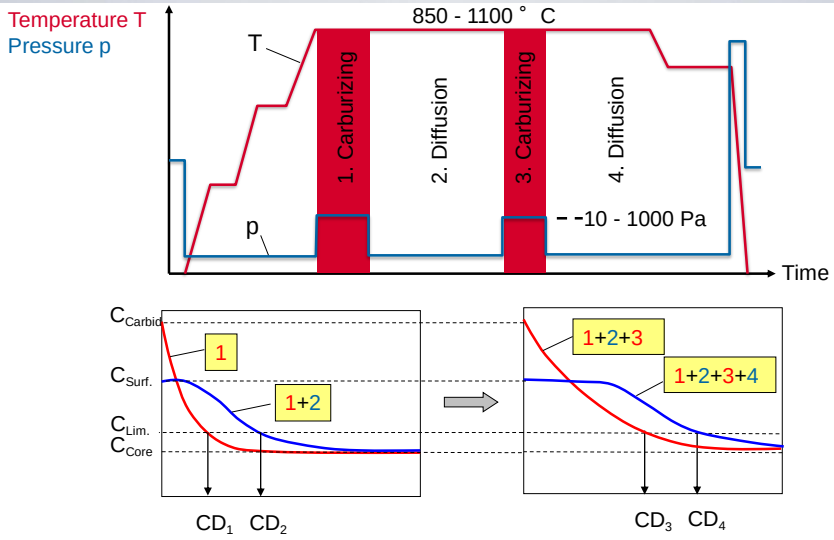
Total view

Detail view

Hardness Profiles of three nozzle bodies from layer 1, 6 and 12

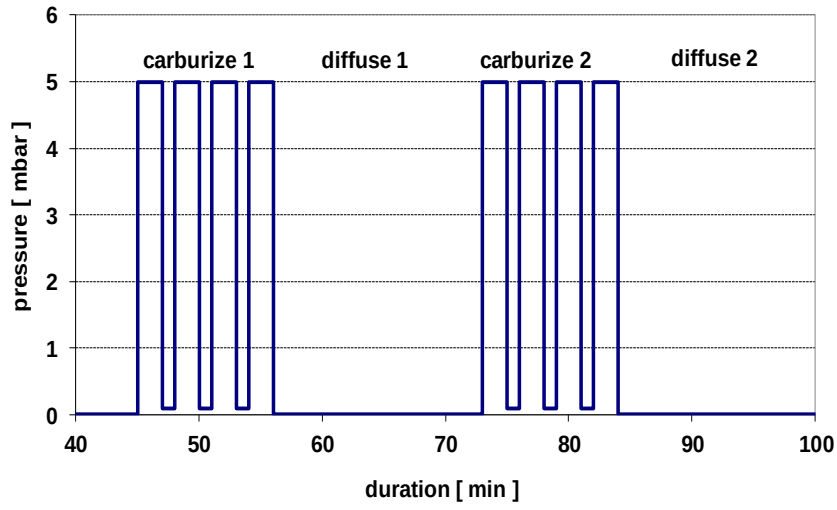


AvaC® Process Procedure

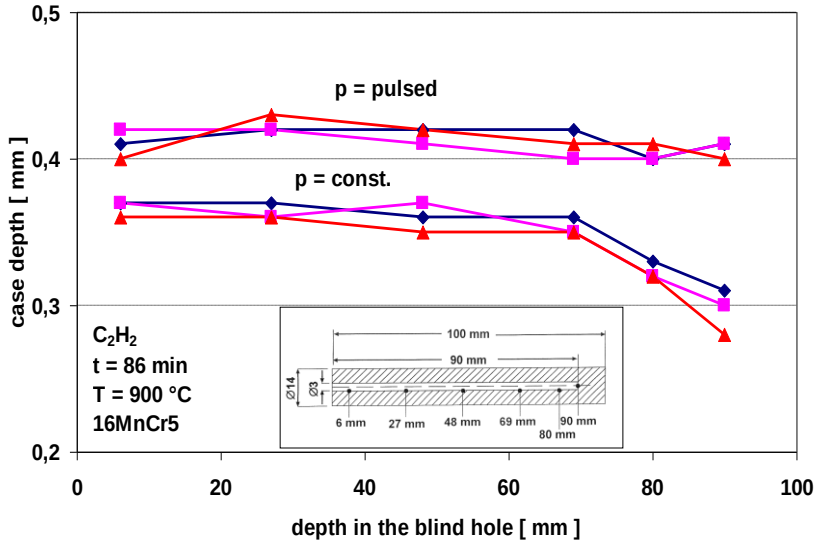


Carbon Profile Development

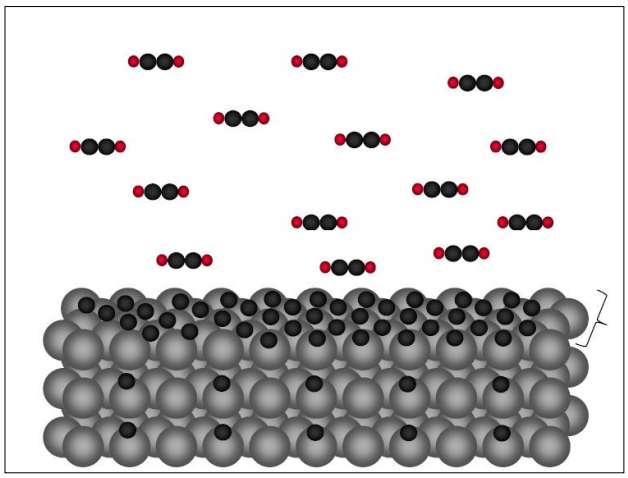
Cycle with pulsed pressure



Case depths with constant and pulsed pressure



Carbon Transfer with Acetylene



Monolayer Carbon

© IWT Bremen

Sensors

Standard Sensors/Controlled Process Parameters:

- Furnace Temperature
- Furnace Pressure
- C_2H_2-Flow
- Boost-/Diffusion Times

Additional Monitoring Sensors:

- H_2-Sensor
- O_2-Sensor

Controlling Sensors (research procects, not in use)

- C_2H_2-flow, boost duration (under development)
- Carbon Transfer (available since years, not reliable)

Carburizing in Hydrocarbons

Advantages	Disadvantages
▪ No internal oxidation ▪ Complex geometries ▪ Higher carbon transfer ▪ Faster carburizing ▪ Shorter cycle duration ▪ Large CHD ▪ Higher temperatures ▪ Very small CHD ▪ Lower gas consumption ▪ Lower consumption expenses ▪ No thermal radiation, no flames ▪ Environmental friendly ▪ No conditioning of the furnace	▪ Formation of soot and tar ▪ Too high carbon content in edges and tips ▪ Effusion of Mn, Cr, Si

High Temperature Carburizing

Material: 14NiCrMo13-4

CHD = 2,0 – 2,3 mm

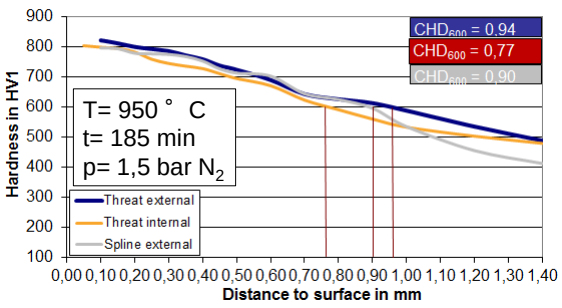
Carburizing Temp.: 1050 ° C

Cycle Time: 10,5 h

Example: Mining Shafts

Specification:	
Material: ~25NiCrMo12-5	
Surface hardness:	> 60 HRC
CHD 600: 0.9 - 1.2 mm	external
> 0.30 mm	internal
Core hardness:	400-500 HV30

Results:	
Surface hardness:	62-64 HRC
CHD 600: 0.90-0.94 mm	external
0.77 mm	internal
Core hardness:	460 HV30



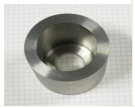
Example: AvaC of aerospace bearings

REQUIREMENTS:

Hardness under the surface:	>697 HV1 (60HRC) at 0.3 mm depth
Core hardness:	402-471 HV30 (41-47 HRC)
CHD 650HV1:	0.8-1.2 mm

SAMPLE PARTS SPECIFICATION

Name:	Bearing, outer ring
Material:	M50NIL
Dimension:	Øo= 66.5 mm Øi= 46.7 mm l=66.5 mm
Weight of part:	0.95 kg

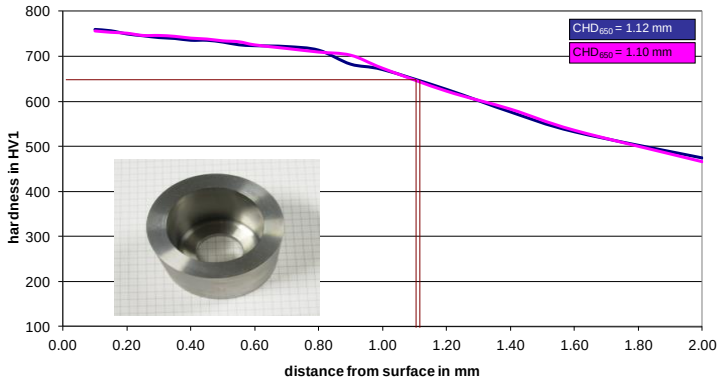


HEAT TREATMENT

LPC (AvaC) temperature:	910 ° C
LPC time:	20 h
Annealing:	580 ° C, 2 h
Hardening temperature:	1080 ° C
Sub-zero treatment:	<-150 ° C, 1 h
Tempering	545 ° C, 2 h

AvaC Results

Surface Hardness:	61.2; 60.9; 60.7 HRC
Core Hardness:	423, 426, 433 HV10
CHD(650HV):	1.10 – 1.12 mm

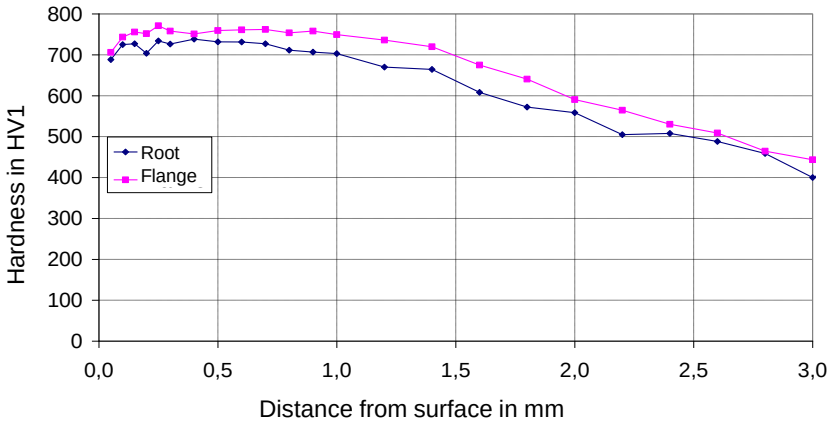


Wind Power

Material: 18CrNiMo7-6
Weight: 128 kg

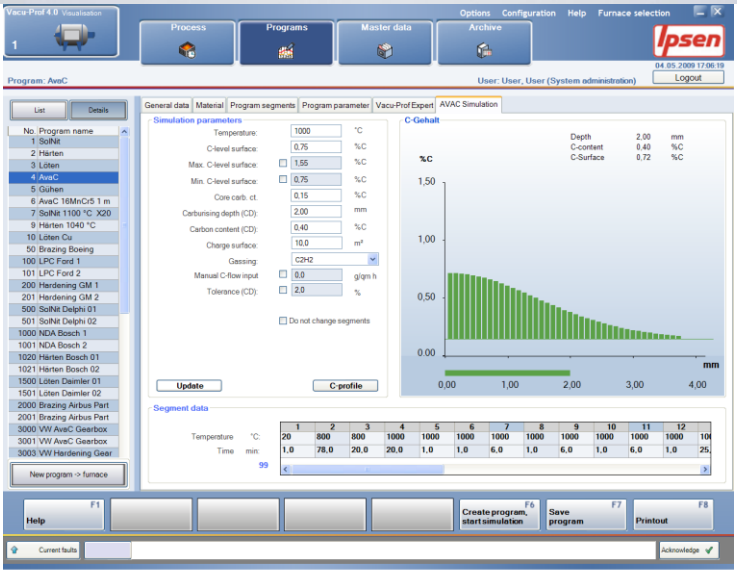
Material: 18CrNiMo7-6
Weight: 60 kg

Hardness Profile after Case Hardening



Furnace: T^2T (AvaC), 12bar, N_2)

Vacu-Prof 4 - Modul, AvaC®-Simulation



Furnaces for Low Pressure Carburizing

Single Chamber,
Two Chamber Chamber (Oil or Gas)
Multi Chamber Furnaces, and
Automatic Furnaces Lines

Turbo²Treater, etc.

RVHT-QGP 20 bar, etc

Ipsen Turbo²Treater®

Size M Installation at Customer

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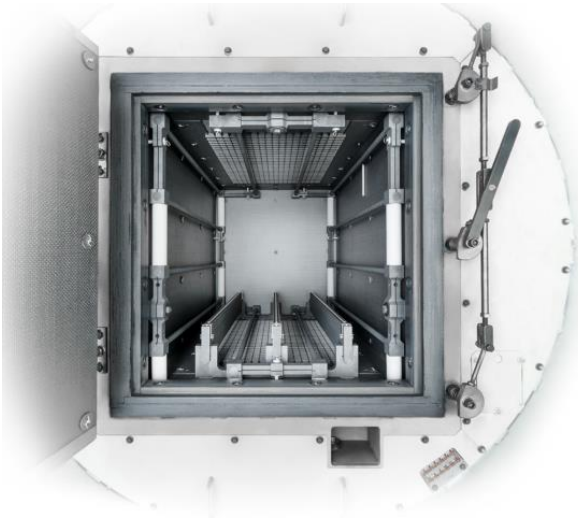
Ipsen Turbo²Treater®



Graphite
Heating Chamber

- **Graphite insulation**
- **Graphite load hearth**
- **Graphite heating elements**
- **Heating Power:**
  "S-size": 75 kW/ 84 kVA
  "M-size": 150 kW/ 166 kVA
  "XL-size": 270 kW/ 297 kVA
- **Special gas distribution system**
- **Heating chamber door closing system (3 closing positions with 1 turn**
- **Load thermocouple feed through connections**

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Single chamber vacuum furnace line

Fully automatic vacuum furnace line
Loader 1.500 kg, rotating to both sides

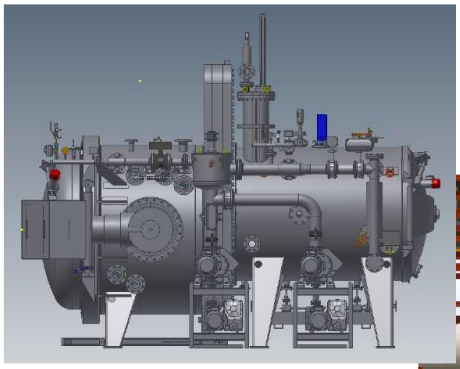
Atlas Copco; Sweden

Single chamber vacuum furnace line

Fully automatic vacuum furnace line
Loader 1.500 kg, rotating to both sides

Atlas Copco; Sweden

Ipsen RVHT-524 - 20bar



Oil quench vacuum hardening furnace

RVFOQ-524
Furnace back side with heating chamber

Vacuum tight inner door

Maintenance door for easy and safe access

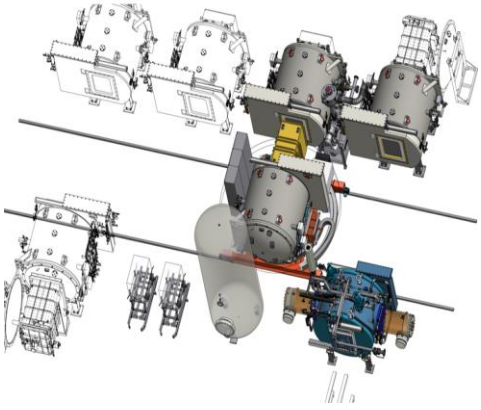
Vacuum pump system

Available standard sizes: S, M, XL

Single and two chamber vacuum furnace line

Israel

ARGOS Multi Chamber System



Example: Automotive shaft

Part:	Shafts
Material (approx.):	20MnCr5
Dimensions:	l= 250 mm
	Ø= 30 – 70 mm
SH:	58-62 HRC
CH:	> 340 HV
CHD:	0.5 + 0.4 mm
Carb.-temp.	950 ° C
Quenching:	20 bar, N_2

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Charge (similar dimensions)

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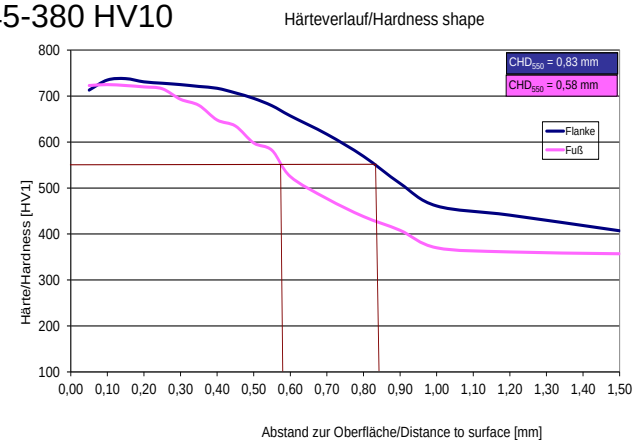
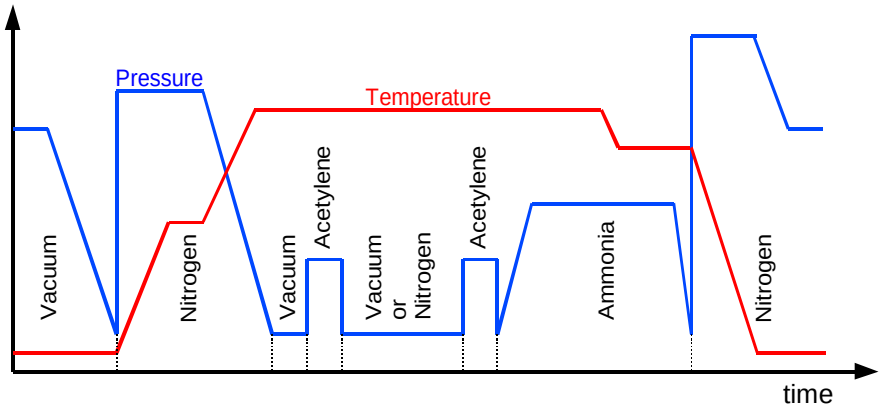
Automotive Results

Surface hardness: 61-62
CHD: 0.58 – 0.83 mm
Core hardness: 345-380 HV10



Quenching: 20 bar, N_2

Low Pressure Carbonitriding Cycle AvaC®-N



Summary

- **AvaC®(-N) Process Description**
  - Boost / Diffuse process
  - Pulsed Pressure Process
  - Acetylene pressure < 10 mbar (Ammonia pressure < 40 mbar)
- **Process Advantages**
  - High carbon transfer rate
  - Optimum case uniformity
  - Part-to-part, load-to-load repeatability
  - Absence of internal oxidation and accurate case uniformity lead to enhanced component quality
  - High furnace availability/reliability due to minimization of soot or tar formation
  - No post cleaning process (with high pressure gas quenching)
- **Furnaces for AvaC**
  - Depending on part size and throughput, Ipsen can provide the right furnace solution for low pressure carburizing

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