

A/C systems A/C compressors

Richard Groot
Product Specialist A/C

Denso Europe BV
The Netherlands

Steve Turner
Sales Executive
Denso UK

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General

Agenda

1. Introduction
2. Denso compressors
3. Denso compressor oils
4. Why do compressors breakdown?
5. Most common compressor failures
6. Additional information
7. Q&A

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Richard Groot, A/C Products - Thermal
A/C and Compressor Applications

Driven Quality

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Compressors

3

AC components

Compressors Identification

Compressor types

Compressor types

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A/C and Compressor Applications

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AC components

Compressors Identification

Previous label

Current label

IAM Part Number: 447260-1010

Compressor type: 6SEU14C

Refrigerant & oil type: HFC134a OIL ND-8

Pre-fill oil quantity: 120cc

Body part number: 447190-7950

Assembly part number: DCP02038

Compressor label

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AC components

Compressors Identification

Search from OE compressor label to DCP via website or TECDOC

Website: www.denso-am.eu/e-catalogue/

Always replace the last digit of the DENSO part number by '0' or search only on the 9-number format, in order to identify the part number in the catalogue:

Example: 447190-7955 -> 447190-7950 = DCP32045

Searching

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AC components

Compressors

Identification

6SEU14C	437100-7040
DESIGN PRESS	
HIGH SIDE 3.53MPa	LOW SIDE 1.67MPa
HFC134a	OIL ND-8 120cc
DENSO S38	Made in Germany

Explanation compressor type

- PA Basic Swash Plate
- S Basic Swash Plate
- SBU Single Swash Plate Type
- SEU Single Swash Plate Type
- SC Scroll
- SV Sliding Vane
- TV Through Vane

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AC components

Compressors

Installation

C mounting

A mounting

Installation position

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AC components

Compressors

Piston type compressor

ND-oil 8

ND-oil 8 Inside

10S

10PA

Fixed displacement

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AC components

Compressors

Piston type compressor

Fixed displacement

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AC components

Compressors

Piston type compressor

ND-oil 8

ND-oil 8 Inside

5SE

6SBU

6SEU

7SBU

7SEU

Variable displacement

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AC components

Compressors

Piston type compressor

External controlled

Control Valve Operator Signal

Variable displacement

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AC components

Compressors **Piston type compressor**

External controlled

Control Valve Operation Signal

Minimum displacement

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AC components

Compressors **Piston type compressor**

External controlled

Control Valve Operation Signal

Step 1

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AC components

Compressors **Piston type compressor**

External controlled

Control Valve Operation Signal

Step 2

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AC components

Compressors **Piston type compressor**

External controlled

Control Valve Operation Signal

Step 3

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AC components

Compressors **Piston type compressor**

External controlled

Control valve is closed

Control Valve Operation Signal

Maximum displacement

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AC components

Compressors **Piston type compressor**

Fixed displacement

Internal controlled displacement

External controlled displacement

Displacement control

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Compressors **Piston type compressor**

Fixed displacement

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AC components **Compressors** **Piston type compressor**

Internal controlled displacement

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AC components **Compressors** **Piston type compressor**

External controlled displacement

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AC components **Discharge capacity**

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AC components **Discharge capacity**

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AC components **Discharge capacity**

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AC components

Discharge capacity

Evaporating Temperature -10°C

Low pressure 1.0 bar

Control valve output 0.81A

External controlled

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AC components

Compressors

Piston type compressor

Material: Aluminum – Hollow body

Coating: Teflon (*DENSO* patent)

Special feature: Small piston clearance (10- to 28µm)

ND-oil 8

Piston clearance with piston rings: ± 40-50µm

Reference: 10µm – 0.01mm

Pistons

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AC components

Compressors

Rotary type compressor

ND-oil 9

TV10 (Through Vane)

FIAT group / Subaru

Suction Port

Discharge Port

ND-oil 9 Inside

Fixed displacement

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AC components

Compressors

Rotary type compressor

ND-oil 8

SV07 (Sliding Vane)

Suzuki / Daihatsu

Suction Port

Discharge Port

ND-oil 8 Inside

Fixed displacement

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AC components

Compressors

Rotary type compressor

ND-oil 8

SC (Scroll)

FIAT group / Daihatsu / Toyota / Subaru

Suction Port

Discharge Port

ND-oil 8 Inside

Fixed displacement

John Deere / Kubota / Renault agri

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AC components

Compressors

Rotary type compressor

ND-oil 11

Electric Driven SC (Scroll)
ES14 – ES27 – ES34

Toyota / Lexus

Suction Port

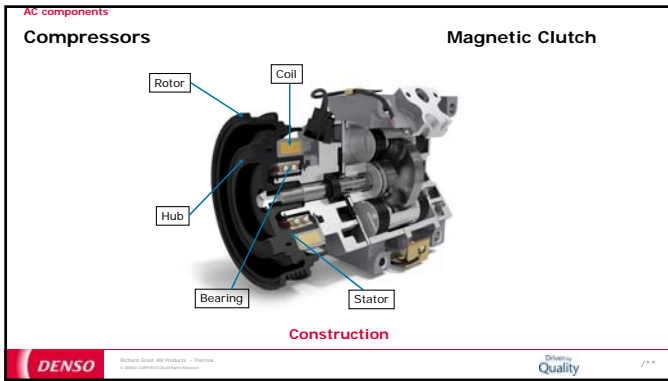
Discharge Port

ND-oil 11 Inside

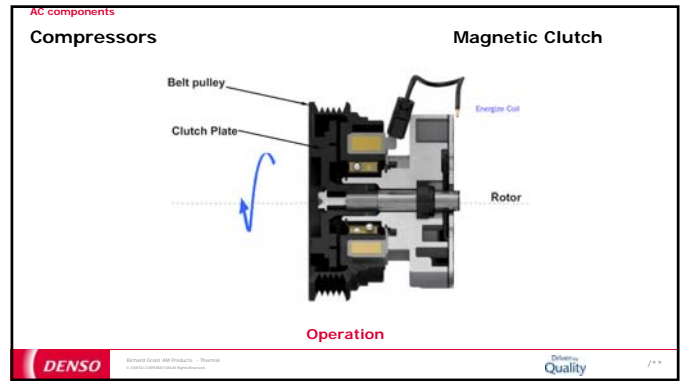
Variable displacement

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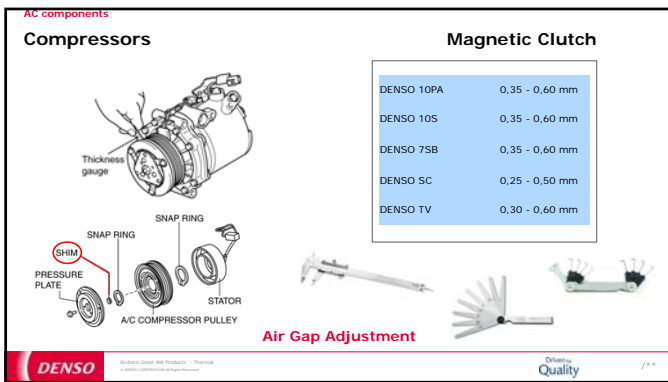
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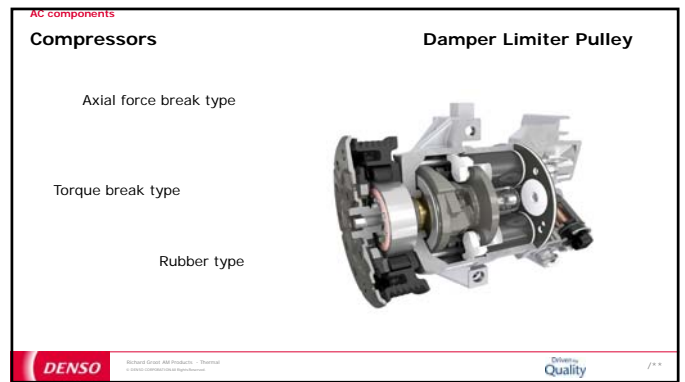
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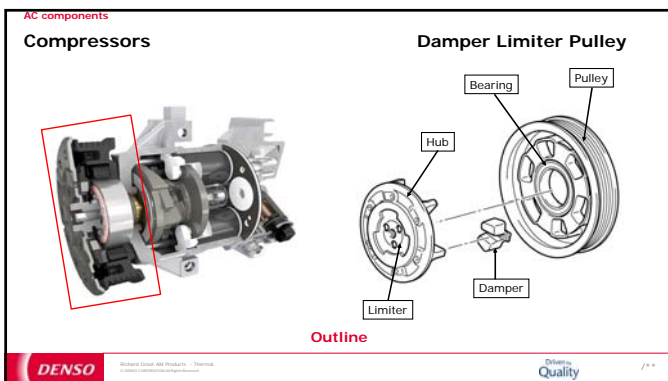
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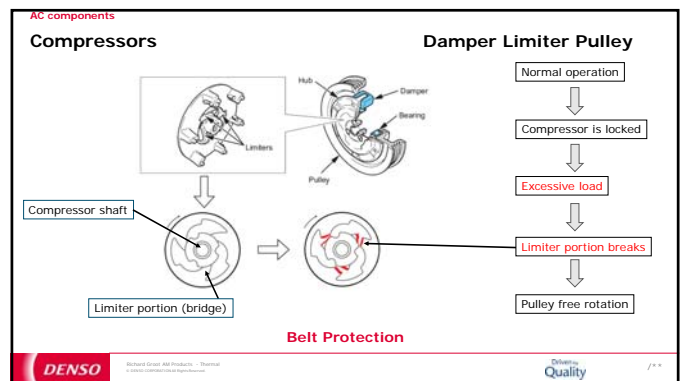
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AC components

Compressors

Damper Limiter Pulley

Item	Code	Explanation
Limiter Type	A	Axial force break type
	B	Torque break type
	R	Rubber
Pulley Material	P	Plastic
	S	Steel
Damper characteristic	D	Drum shape
	C	Compression specifications
	N	Elliptic shape
Option	No letter	None
	W	Weight

DL-Pulley Types

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AC components

Compressors

Damper Limiter Pulley

Axial force break type

Limiter breaks

Axial force break type

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AC components

Compressors

Damper Limiter Pulley

Torque Break Type

Torque Break Type + Weight

Torque break type

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AC components

Compressors

Damper Limiter Pulley

Rubber Type

Rubber type

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AC components

Compressors

Damper Limiter Pulley

Rubber Type

DL-Pulley rotational direction

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AC components

Compressors

Damper Limiter Pulley

Torque Break Type


DL-Pulley rotational direction

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AC components

Compressors



Audi Direct drive

Damper Limiter Pulley



VW Direct drive

DL-Pulley types

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Compressor oils






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Compressor oils

DENSO compressor oils

ND-oil 8 ND-oil 9 ND-oil 11 ND-oil 12

HFC134a

- DENSO ND-Oil 8 → ISO 46 (Poly Alkaline Glycol)
- DENSO ND-Oil 9 → ISO 46 (Poly Alkaline Glycol)
- DENSO ND-Oil 11 → POE (Polyolester) oil (electric compressors)
- DENSO ND-Oil 12 → ISO46 (Poly Alkaline Glycol + additives)



DENSO compressor oil program

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Compressor oils

DENSO compressor oils

ND-oil 11 ND-oil 12

HFO1234yf

- DENSO ND-Oil 11 → POE (Polyolester) oil (electric compressors)
- DENSO ND-Oil 12 → ISO 46 + additives


DENSO compressor oil program

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Compressor oils


PAG oils & ND-oils



PAG oil
Single End Capped



Ordinary PAG oil
Double End Capped



ND-oil 8 & 12
Double End Capped

Three quality levels

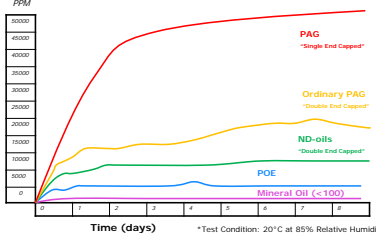
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Compressor oils

PAG oils & ND-oils

Hygroscopicity



Moisture absorption

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Compressor oils

ND-oils storage & handling

Looks like

Clear & Transparent

Appearance

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Compressor oils

ND-oils storage & handling

Do not use!

Looks like

Saturated with moisture

Appearance

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Compressor oils

ND-oils storage & handling

Moisture free oil feed system

Summary

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Compressor oils

ND-oils

Do not mix oils

Only use oil specified by the compressor manufacturer.

Do not use universal oils!

Summary

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Compressor oils

PAG oils & ND-oils

Part 1

Part 2

Oil bulletins

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Why do compressors breakdown?

Summary

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Compressor replacement

Why do compressors breakdown?

99.9% of all failures are not product related

1. No maintenance of A/C system.
2. Irregular engine rotation or too much drive belt movement. (torque fluctuation)
3. Insufficient knowledge of "how to repair A/C system."
4. The use of wrong oils and additives.
5. No maintenance of service equipment.




The general idea of technicians, promoted by the IAM suppliers;
"Car Air Conditioning is easy, low investment, quick money maker"

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Compressor replacement

1) No maintenance of A/C system



Preferably once every year, with a minimum of once every two years

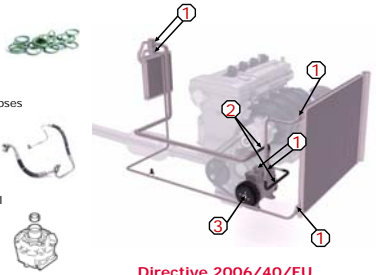
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Compressor replacement

1) No maintenance of A/C system

- ① O-rings
- ② Rubber hoses
- ③ Shaft seal



One evaporator system = 40 gram
Two evaporator system = 60 gram

Directive 2006/40/EU

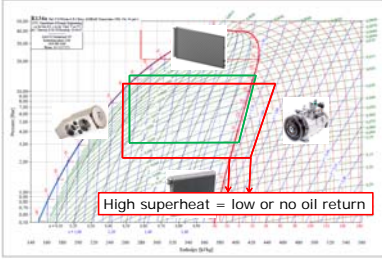
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Compressor replacement

1) No maintenance of A/C system

Why?



Low Refrigerant levels!

Normal level!

1. LP: 2.0 bar / 18.0°C
2. HP 13.8 bar / 46.8°C
3. Evap out: 2°C
4. Compressor out: 96°C
5. Condenser out: 40°C

Superheating: 8.1°C
Sub cooling: 6.5°C

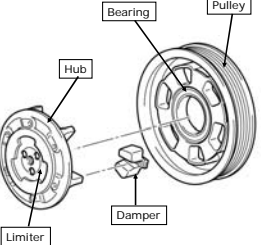

High superheat = low or no oil return

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Compressor replacement

2) Torque fluctuation


Drive system of compressor

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Compressor replacement

3) Insufficient knowledge



AC system blockage

No O-ring replacement

Too much oil

Using old oil

A/C machine operation

Not changing all necessary parts

A/C service & repair is not easy

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Compressor replacement

4) Use of wrong oils & additives

Too much UV-Dye

ND-oil 8 & PAO

Conditioner or leak stop

ND-oil 8 & ND-oil 11

ND-oil 6

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Compressor replacement

5) No maintenance of service equipment

Maintenance schedule: Approximately every 150 operation hours, depending on manufacturer.

- Change vacuum pump oil
- Change filters
- Calibration of weight scales / load cell

Common practice:

- Maintenance 1x a year (off season)
- No maintenance

Main problems are:

- Pollution of service station
- The use of different type of oils and UV-Dyes
- Vacuum pump will not reach its maximum vacuum level
- Incorrect refrigerant charging amount

Maintenance cost:
Approx. 100 Euro parts
+ labor (± 2hrs)

Do not ignore service warning!

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Compressor replacement

5) No maintenance of service equipment

Oil drain bottle

Vacuum pump oil

Torn filter

Clogged valve body

Clogged tube

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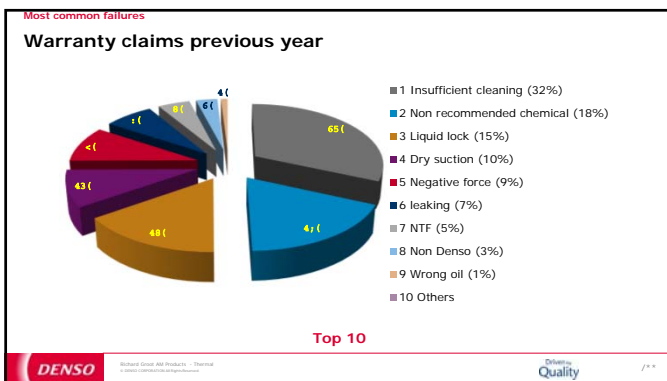
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Most common compressor failures

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1) Insufficient cleaning

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Most common failures

1) Insufficient cleaning



Dirty suction port

Result



Dirty discharge port



Contaminated oil



Dirty ports



Dirty control valve

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Most common failures

1) Insufficient cleaning

Why?

Not replacing all necessary parts



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2) Chemicals & additives

DANGER

HAZARDOUS CHEMICALS



Warning
Cleaning chemicals




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Most common failures

2) Chemicals & additives




Insufficient lubrication because of the use of flushing chemicals.


Result




Too much UV-dye: Reducing viscosity and lubrication performance



Unauthorized additives, causes a chemical reaction with the original ND-oil 8



Additives causing swelling of rubber packing and O-rings



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Most common failures

2) Chemicals & additives


Why?


Use of imitation refrigerant, flushing chemicals and additives





Warning
Cleaning chemicals





Additives

DANGER

HAZARDOUS CHEMICALS


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Most common failures

2) Chemicals & additives


Result




"Sticky" rotation



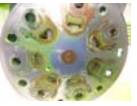
Jelly substance



Pistons are glued to the cylinders



Compressor remains in minimum displacement



Heavy rust on valve plates

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Most common failures

2) Chemicals & additives

Bonding of pistons in cylinders **Why?**

Production process low quality After Market condenser

Installation

Flux, UV-Dye & ND-oil 8

Jelly substance

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Most common failures

2) Chemicals & additives

Why?

NEW MINDSET
NEW RESULTS

After Market is price driven, instead of.....

..... quality driven

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3) Liquid lock

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Most common failures

3) Liquid lock (1)

Result

Too much oil in discharge port

Scratch marks on swash plate

Too much oil drained from the old compressor

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Most common failures

3) Liquid lock (1)

Why?

Too much oil in the A/C system

DCP32060

New compressor is pre-filled

Not removing remaining oil

Refilling machine settings

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Most common failures

3) Liquid lock (2)

Result

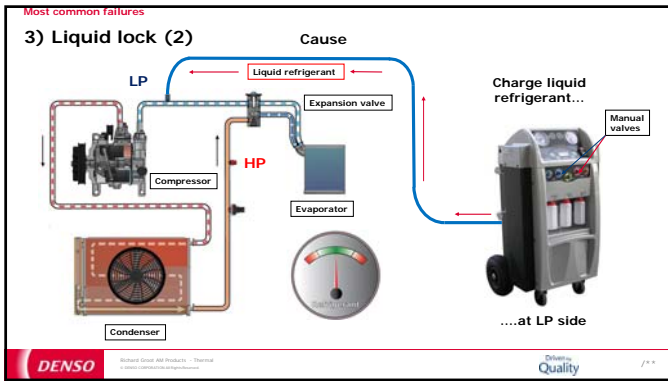
Discharge port is clean and wet by oil

Swash plate damage

Suction port is clean and dry

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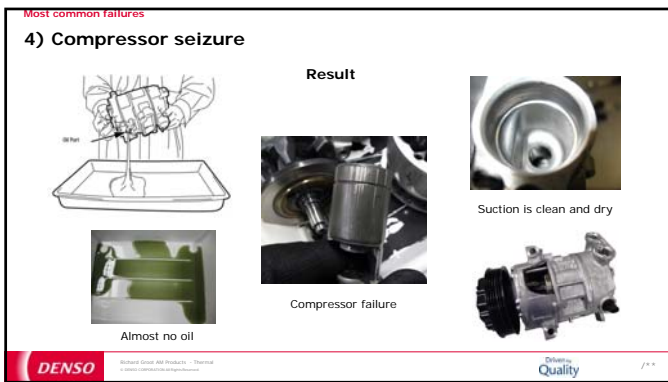
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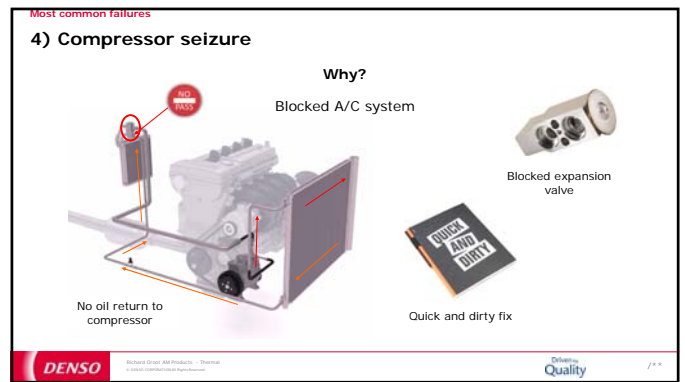
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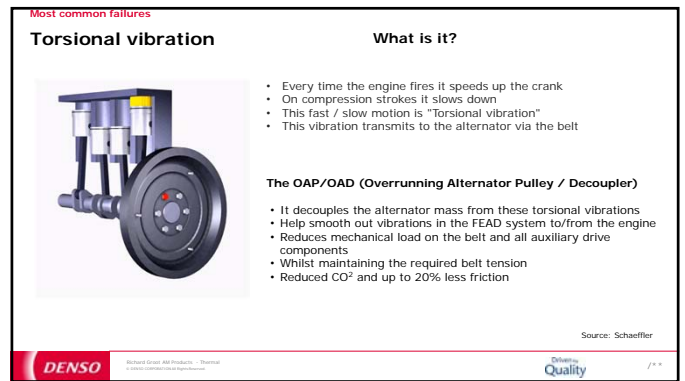
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Most common failures

Front End Auxiliary Drive belt system (FEAD)

Power steering pump

Water pump

AC compressor

Crankshaft TVD

INA FEAD belt tensioner

Overrunning Alternator Pulley (OAP) or Overrunning Alternator Decoupler (OAD)

Alternator

FEAD belt

Source: Schaeffler

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Most common failures

The FEAD belt system is increasing in complexity

Peak of complexity has been reached

Downsizing
Downsizing creates stronger rotational irregularities in the crankshaft

COMPLEXITY

Starter Generator usage is growing
10 years ago we were using 90 amp Alternators. Now they are around 140 up to 200 amp

STRESS ON COMPONENTS IS INCREASING

Every car has Air Con

Source: Schaeffler

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Negative force - DL-pulley

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Most common failures

5) Negative force - DL-pulley

Result

Broken limiter of DL-Pulley

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Most common failures

5) Negative force - DL-pulley

Why?

Broken limiter of DL-Pulley

- Free run pulley, alternator, is seized (OAP -OAD)
- Torque fluctuation (rough idle, rough running)
- Chip tuning
- Crankshaft damper is broken (TVD)
- Automatic tensioner is broken
- Compressor internal resistant is too high
- Dual mass flywheel worn / conversion kit installed
- Vacuum lock**

Hub (integrated with Pulley)

Rotation

Limiter

Compressor Shaft

Rotation

Limiter Breaks

Lock

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Most common failures

5) Negative force - DL-pulley

Why?

Vacuum lock

Expansion valve

Evaporator

Compressor

Condenser

Engine start

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Most common failures

5) Negative force - DL-pulley

Why? VW direct drive system

Alternator Freewheel
Air conditioner compressor
Vane pump for power steering
Locked overrunning pulley
DCP32006K

Locked overrunning pulley

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Most common failures

5) Negative force - DL-pulley

Why? Drive system issues

Excessive belt movement
Normal belt movement

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6) Leaking compressor

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Most common failures

6) Leaking compressor

Result

Leakage via oil drain plug.....

.....or LP & HP connections

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Driving Quality

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Most common failures

6) Leaking compressor

Why?

Always replace packings
Torque 20Nm
Not using parts kit!

Not replacing O-rings

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7) No trouble found (NTF)

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Driving Quality

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Most common failures

7) No Trouble Found (NTF)

Result

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Driving Quality

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Most common failures

7) No Trouble Found (NTF)

Why?

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Driving Quality

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Most common failures

7) No Trouble Found (NTF)

Magnetti Marcelli

Temp select ECSS06

PWM signal generator

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Driving Quality

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Most common failures

7) No Trouble Found (NTF)

Compressor Control Valve Check

Alternative

Maximum 1 minute!

Check Polarity!

1 Amp fuse

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Driving Quality

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Most common failures

7) No Trouble Found (NTF)

Alternative

Check Polarity!

Do not forget to erase the DTC's!

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Driving Quality

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8) Non DENSO compressors

DENSO

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Most common failures

8) Non DENSO compressors

Result

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Most common failures

8) Non DENSO compressors

Why?

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9) Use of wrong oils

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Most common failures

9) Use of wrong oils

Result

Wrong viscosity
ND-oil 8 & PAO oil
ND-oil 8 & ND-oil 11
ND-oil 6

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Most common failures

9) Use of wrong oils

Why?

Do not mix oils!

Do not use universal oils!

STOP

Only use oil specified by the compressor manufacturer.

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10) Others


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Most common failures

10) Overheated compressor

Result



Burned Denso label

Burned reed valves

Low refrigerant / oil amount

Burned oil

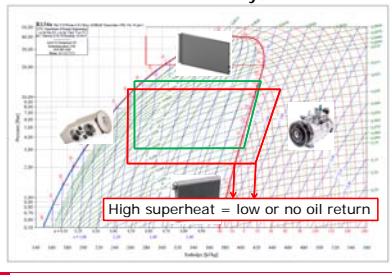
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109

Most common failures

10) Overheated compressor

Why?



High superheat = low or no oil return

Low Refrigerant level

Low level

1. LP: 2.0 bar / 18.0°C
2. HP: 13.8 bar / 48.3°C
3. Evap out: 9.5°C
4. Compressor out: 98°C
5. Condenser out: 48°C

Superheating: 81°C
Sub cooling: 4.8°C


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Most common failures

10) Overheated compressor

Heat radiation



Dirt accumulating between radiator and condenser

Worn condenser

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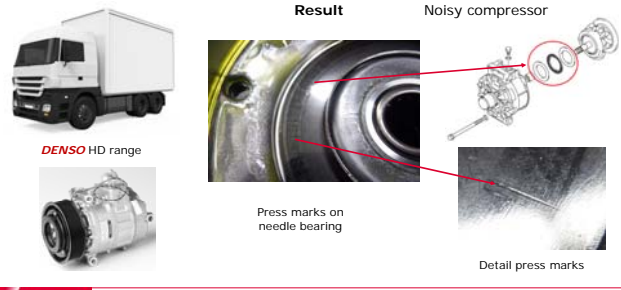
111

Most common failures

10) Noisy compressor

Result

Noisy compressor



DENSO HD range

Press marks on needle bearing

Detail press marks

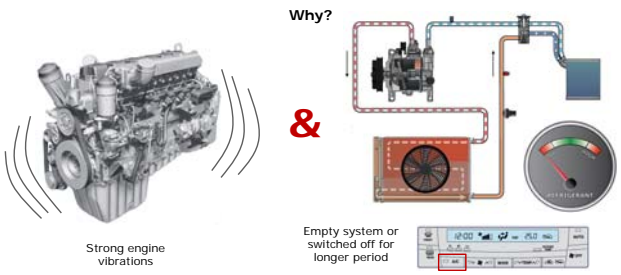
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Most common failures

10) Noisy compressor

Why?



Strong engine vibrations

Empty system or switched off for longer period


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Most common failures

10) No operation

Result



Mercedes-Benz application


No Trouble Found (NTF)

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Most common failures

10) No operation

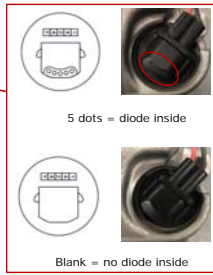


Selected wrong Mercedes-Benz application

Why?



Diode inside?



5 dots = diode inside


Blank = no diode inside

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Most common failures

10) No operation



Compressor Control Valve Identification


Technical bulletin

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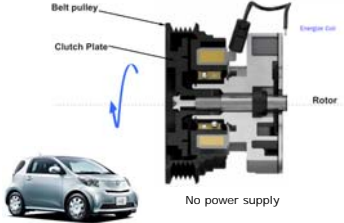
Most common failures

10) No operation



DCP50125

Result Magnetic clutch does not engage




Belt pulley

Clutch Plate

Rotor

Engage coil

No power supply




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Most common failures

10) No operation




Faulty refrigerant flow sensor



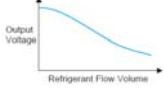
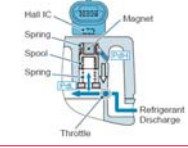
No DENSO spare part

Why?



4.4V

No output of refrigerant flow sensor

Hall IC

Magnet

Spring

Spring

Spring

Refrigerant Discharge


Throttle

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Most common failures

10) No operation




DCP32068

Result



VW Crafter 2006-2016




Rubber damper of DL-Pulley failed

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119


Most common failures

10) No operation




DCP32068

Why?



VW Crafter 2006-2016



VW repair kit 2E0 898 810

Negative force / torque fluctuation

Picture: Schaeffler

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Additional information

DENSO Webinars (English)

LEAGUE OF TRUE MECHANICS

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Additional information

DENSO AM.CO.UK website

www.denso-am.co.uk

www.denso-am.eu/downloads?cat=ac-engine-cooling&group=ac-compressor

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Additional information

E-learning (LoTM)

www.denso-technic.com

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Additional information

DENSO webinars

<https://www.qotostage.com/channel/f899880d0b2f43b59a88b3c2862a13ce>

- Free access to pre-recorded webinars and training videos
- Watch On Demand

Recently added

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Thank you for taking part!

Driven by Quality

Any questions...?

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