

***Cost efficient  
R744 AC System  
for Compact Vehicles***

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# Agenda

- **Motivation**
- **cost efficient R744 AC System**
  - **Targets**
- **Test vehicle**
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  - **R744 Compressor**
- **Results**
  - **AC Performance**
  - **Driveability (AC-Stumble)**
- **Conclusions**

# Motivation

- Today's R134a AC-Systems could be classified in three types

	<b>R134a</b>	
	<b>Compressor Type</b>	<b>Sys. Cost</b> (no currency)
<b>Upper class</b>	external controlled Compressor	550 – 500
<b>Middle class</b>	external & internal controlled Compressor	480 – 430
<b>Compact class</b>	fixed displacement & internal controlled Compr.	410 – 380

# Motivation

- majority of realized R744 Vehicle cooling systems use external controlled compressor

	R134a		R744		
	Compressor Type	Sys. Cost	Compressor Type	Sys. Cost	Cost increase
<b>Upper class</b>	external controlled C.	550-500	external controlled C.	726-660	<b>132%</b>
<b>Middle class</b>	ext. & int. controlled C.	480-430	"	726-660	<b>152%</b>
<b>Compact class</b>	fixed & int. controlled C.	410-380	"	726-660	<b>175%</b>

⇒ **the cost increase of more than 50% is not acceptable at least for compact class vehicles**

# Motivation

- internal controlled R744 Compressor is not feasible  
(high pressure difference, needed high pressure control)

	R134a		R744		
	Compressor Type	Sys. Cost	Compressor Type	Sys. Cost	Cost increase
<b>Upper class</b>	external controlled C.	550-500	external controlled C.	726-660	<b>132%</b>
<b>Middle class</b>	ext. & int. controlled C.	480-430	Ext. contr. C.	726-660	<b>152%</b>
			Fixed C.	550-490	<b>115%</b>
<b>Compact class</b>	fixed & int. controlled C.	410-380	Fixed displace. C.	550-490	<b>134%</b>

⇒ **cost efficient R744 AC System with fixed displacement Compressor is needed at least for compact vehicles.**

# cost efficient R744 AC System

## Targets:

- Cooling performance equal to R134a cost efficient AC systems (similar to R134a internal controlled and fixed Systems)
- driven by fixed displacement compressor
- system control by clutch cycling
  - EVAP icing avoided by EVAP air outlet temperature sensor
  - pressure switch at Comp. outlet (System protection)
  - temperature sensor at Comp. outlet (System & Oil protection)
- minimized AC stumble
- NVH equal with R134a Systems

# cost efficient R744 AC System

realized by Visteon exemplarily in test vehicle:

- Citroen C3
- 1,4 liter petrol engine
- manual gear shift
- climate control by EATC



# Test vehicle

	Current R134a Citroen C3	Cost efficient R744 AC System in Citroen C3	
<b>Condenser / Gascooler</b>	460 * 380 * 17 mm	460 * 380 * 12 mm	
<b>Compressor</b>	120cc internal controlled	15cc fixed displacement	
<b>Evaporator</b>	240 * 200 * 60 mm	240 * 200 * 45 mm	
<b>Accu / IHX Expansion- Device</b>	— (TXV System)	Visteon combined R744 Accu/IHX  high Pressure Orifice	



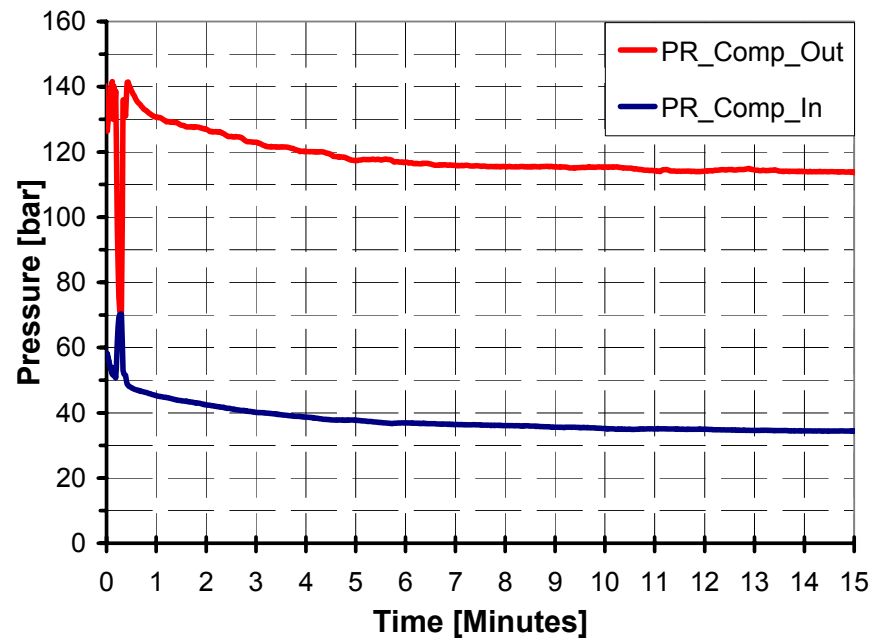
# ***R744 fixed displacement Compressor***

- Fixed displacement  
(15cc)
- lug distance 121/55mm  
(small VDA)
- Internal oil separator
- Low rotational inertia  
⇒ low engagement torque
- Low weight: < 5,0 kg (incl. clutch)

# Test vehicle – AC Performance

## climate Wind chamber test:

- 40°C / 40% rh  
no sun load
- 15 Minutes  
50 km/h  
3. gear (2000rpm)
- EATC setting “Lo”
- full blower
- recirc mode



# Test vehicle – AC Performance

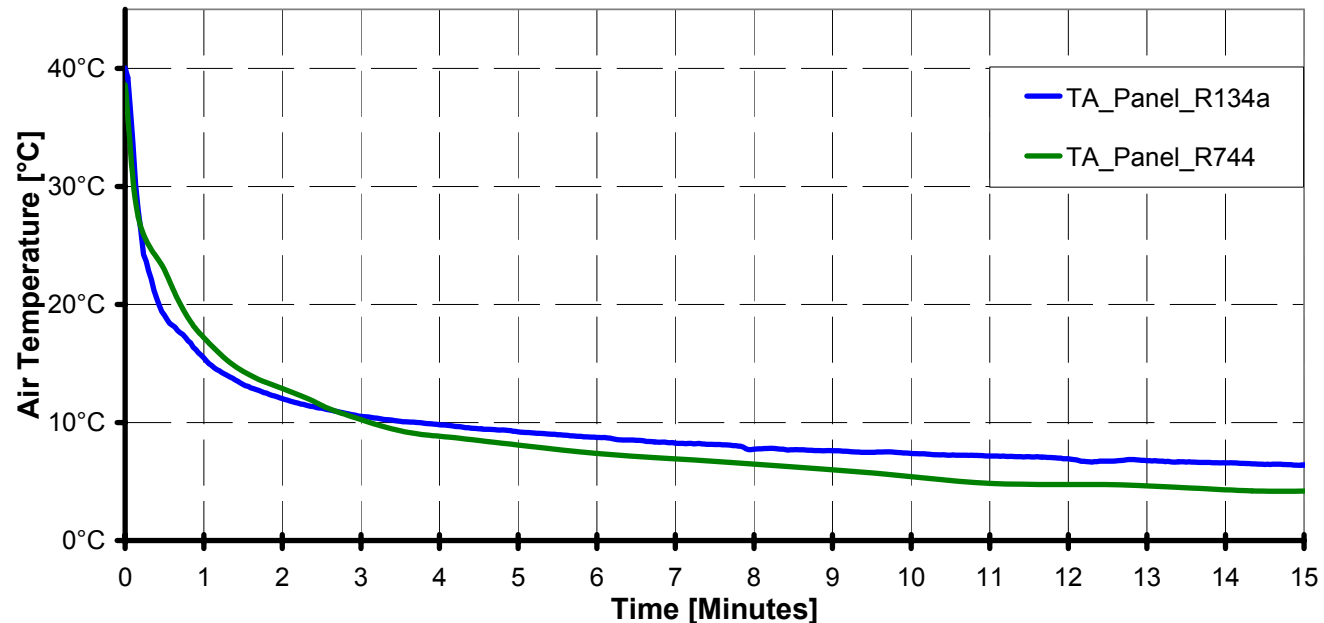
## Conclusions:

- any compressor clutch off during pull down phase has deep impact on cooling performance
- in first phase of pull down with low pressure differences the expansion device needs to be wide open to avoid clutch cycling because of high pressure or high temperature
- for later phase the refrigerant mass flow has to be limited to avoid clutch of signals because of potential EVAP icing

⇒ **variable mechanical Orifice is needed**  
either difference pressure or high pressure driven

# Test vehicle – AC Performance

climate Wind chamber test:

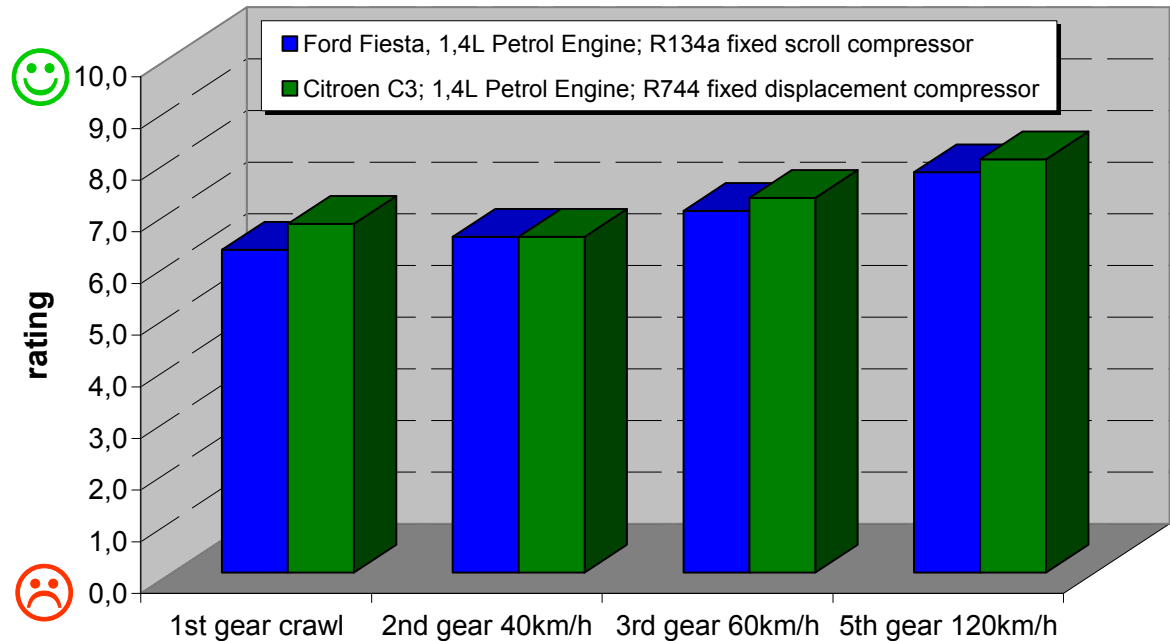


- baseline test with R134a current AC system before rebuild
- ⇒ **R744 AC Performance with 15cc fixed compressor is similar to current R134a System (120cc) inside Citroen C3.**

# Test vehicle – Driveability

## AC Stumble Test at mild ambient:

- beside the performance is the driveability the main comfort criteria for fixed displacement compressor Systems
- AC-Stumble is compared with R134a fixed displacement AC system by subjective ratings



⇒ **AC Stumble of R744 cost efficient AC System competitive.**

# Conclusion

- For a 100% penetration of the mobile AC Systems with R744 cost efficient fixed displacement Compressor Systems are strictly required
- The shown AC performance is similar with the replaced R134a internal controlled compressor system
- The negative impact of AC Stumble is complete to current R134a Systems
- R744 System is fully integrated in current AC control



Thanks for your attention.

Questions ?