



Additives For Flexible Polyurethane Foams

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Air Products & Chemicals, Inc

Current Additives for Flexible Molded Applications

Additives for auto seatings

Catalysts	gelling	Dabco 33LV	Gelling catalyst
		Dabco 33LX	Low emission version of 33LV
		Dabco 8154	Delay action gelling catalyst
		Dabco NE1070	Non-emission reactive gelling catalyst
	blowing	Dabco BL11	Blowing catalyst
		Dabco BLX-11	Low emission version of BL11
		Dabco BL17	Delay action blowing catalyst
		Dabco NE210	non-emission reactive blowing catalyst
		Dabco NE 300	non-emission reactive blowing catalyst
	balance	Dabco MP601	Delay action balance catalyst for fast demold
	Surface cure	Polycat 15	Improve surface cure, non- emission
		Polycat 58	Improve surface cure, non- emission
		Dabco MP602	Improve surface cure, non- emission
Surfactants		Dabco DC2525	Low fogging, low efficiency silicone for MDI foams
		Dabco DC2585	Low fogging, medium efficiency silicone for MDI/TDI foams
		Dabco DC 6070	Low fogging, high efficiency silicone for TDI foams
		Dabco DC3043	Standard co-surfactant for improved surface appearance
		Dabco DC 5164	high stabilizing surfactant for high solids TDI foams
		Dabco DC 5950	Hot cure surfactant with improved flammability performance
Others	Block agent	Dabco BA100	Non-fugitive blocking agent allowing control of cream times and cell opening
	Crosslinker	Dabco CL420	Non-fugitive novel cross-linker providing significantly improved humid aged physical properties
	Metal catalysts	Dabco T-12	Industry standard (DBTDL) for case
		Dabco MB20	Bismuth based catalyst, offering tin free alternatives in CASE

Non-Emission Additives for Flexible Molded Applications

Non-Emission Family of Additives for Flexible Molded Applications

Gel Catalysts

Dabco NE1070

Blow Catalysts

Dabco NE210

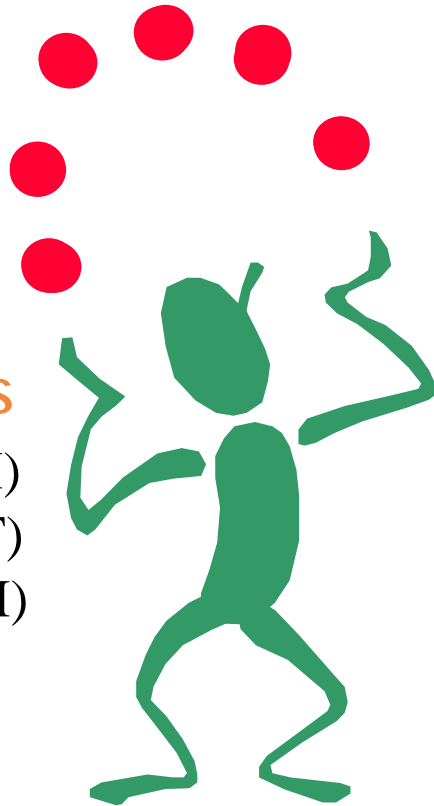
Dabco NE300

Silicone Surfactants

Dabco DC6070 (TDI)

Dabco DC2585 (M/T)

Dabco DC2525 (MDI)



Surface Cure Catalysts

Polycat 15

Polycat 58

Dabco MP602

Blocking Agent

Dabco BA100

Novel crosslinker

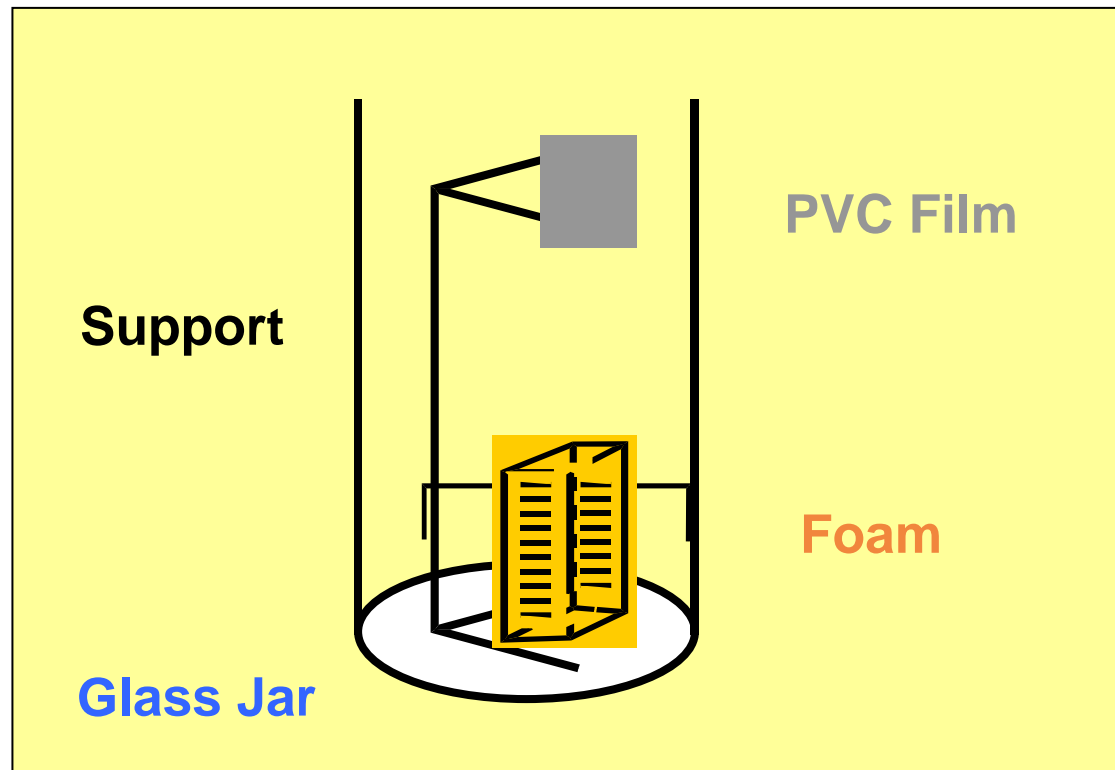
Dabco CL420

Emission test methods by auto. OEM

Method	OEM	Standard	
PVC-Staining Test	VW/Audi PSA	PV 3937 D10 5496	100°C/72h
Dynamic Head Space	Daimler/Chrysler Toyota PSA BMW	VDA 278 TSM0 509 G D10 5495 VDA 278-type	90°C/0.5h > 120°C/1.0h 65°C/0.2h 80°C/0.3h 90°C/0.5h > 120°C/1.0h
Fogging	Renault	DIN 75201 type	100°C/16h
Fogging	Ford	DIN 75201, A = photometric B = gravimetric	100°C/3h 100°C/16h
Fogging	GM / Opel	GM 60326 A = gravimetric B = photometric	100°C/16h 100°C/3h

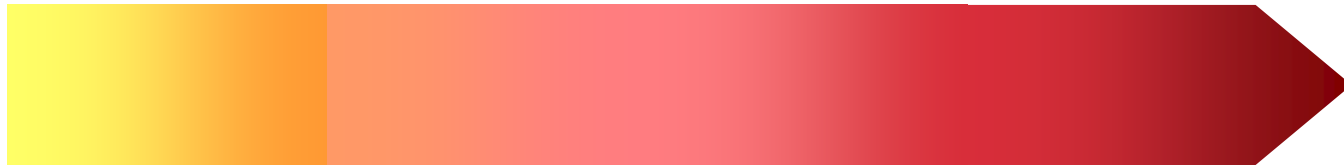
PVC Staining Test

- PVC films exposed to foam at 100°C in sealed chamber for 72 hours
- Color change quantified using Gardner colorimeter



Emission Issue: PVC Staining

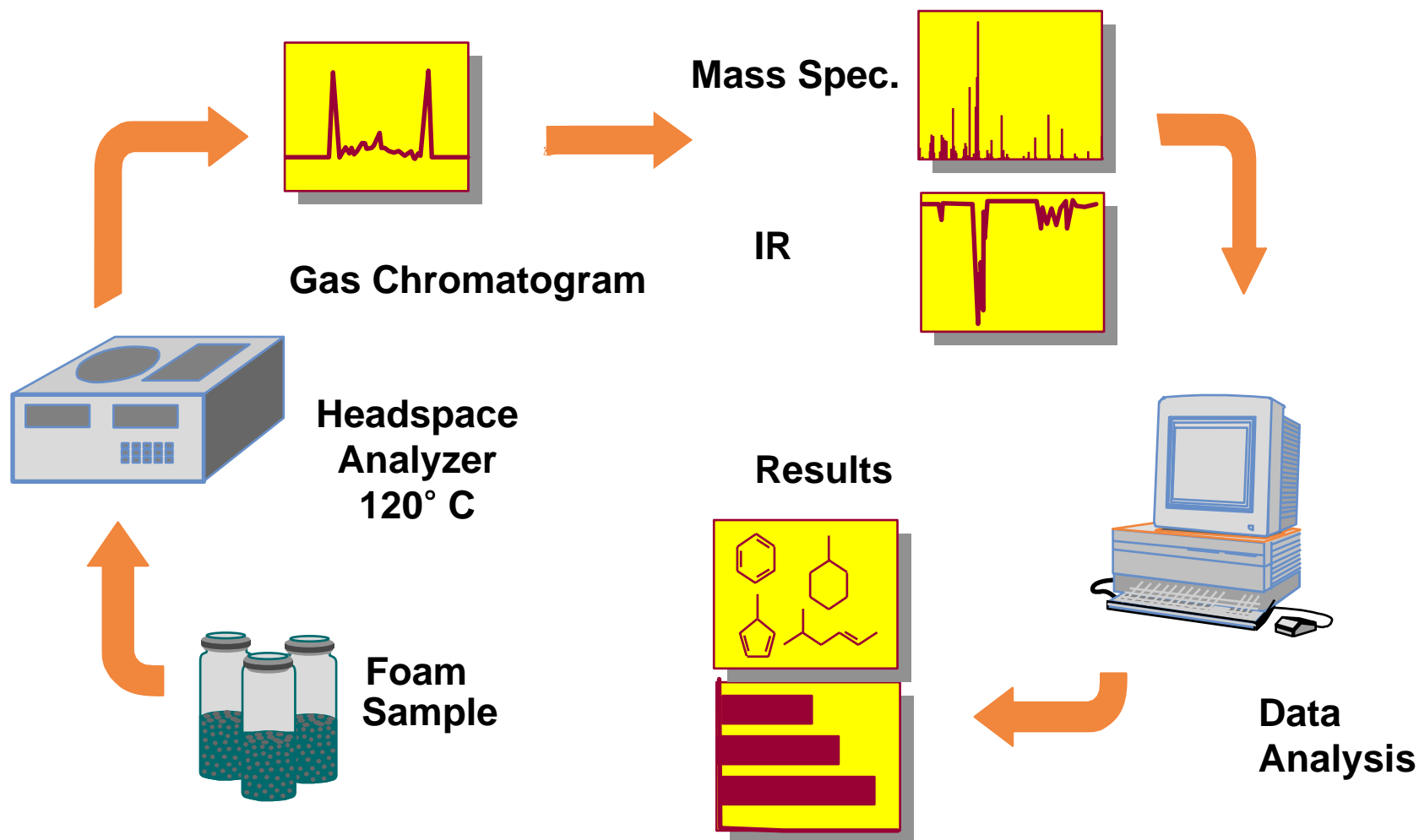
- **Staining ranges from yellow to dark red**



- **Staining is caused by migration of amines and other foam components into the PVC**
- **Amines can then react with the vinyl generating colored species**

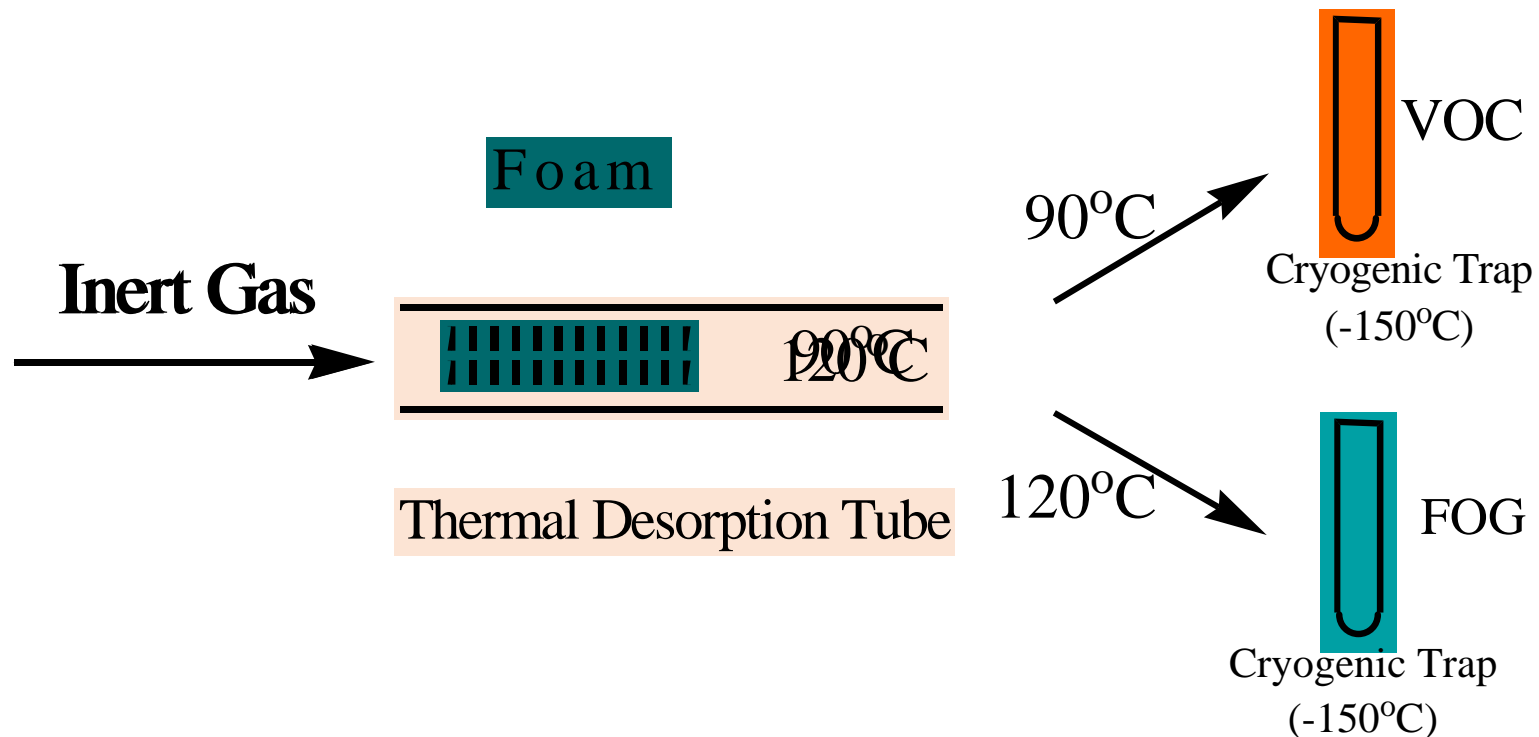
How to check for emissions?

Static Headspace Analysis Equipment



VOC / FOG Emission Test Procedure

- Thermal desorption testing method (dynamic headspace): VDA 278
- Standard test used by automotive industry



Silicone Performance in TDI and MDI Systems

Low Emission Silicone Surfactant

-Dabco DC6070 in T/M system

	Dabco DC5169 Dabco DC5164	Dabco DC6070
Use level, pphp	0.6 / 0.2	0.7
Density, Kg/m ³	39	
Index	100	
Fogging (DIN 75201)	0.6 mg	50% Reduction
VOC emissions	426 ppm	20% Reduction
FOG emissions	470 ppm	25% Reduction

Low Emission Silicone Surfactant

-Dabco DC 2525 in MDI system

	VOC	FOG	Total
	90C / 0.5 h	120C / 1.0 h	
DC 2525	36 ppm	21 ppm	57 ppm
Low-Emission Industrial standard	113 ppm	20 ppm	133 ppm

- Emission reduction app. 50% compared to standard
- Performance similar to low-emission industrial standard

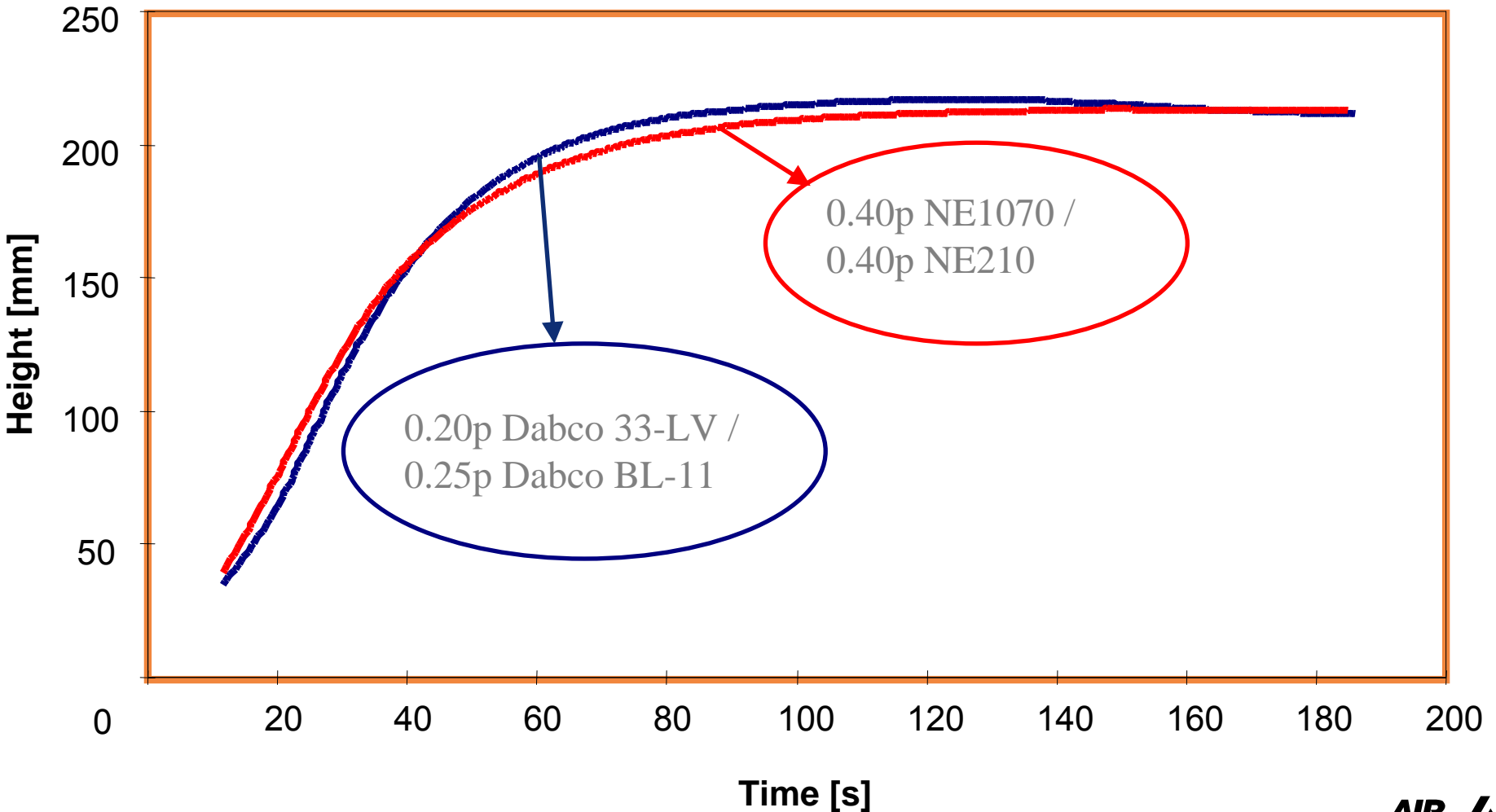
Catalysts Performance in TDI and MDI Systems

Catalyst Packages Evaluated

T/M Formulation	Standard
Dabco 33 LV	0.20 pphp
Dabco BL 11	0.25 pphp
	Non-emission
Dabco NE 1070	0.40 pphp
Dabco NE 210	0.40 pphp

- Molded Density = 38 Kg/m³
- Foam Index 90 – 100

Standard vs. Non-emission Catalysts -- Equal Reactivities



Reduced Emissions with Dabco NE1070 and Dabco NE210

	Standard	Non-fugitive
Dabco 33-LV	116 ppm	-
Dabco BL-11	315 ppm	-
Dabco NE1070	-	Not detected
Dabco NE210	-	Not detected
Others	490 ppm	426 ppm
Total VOC (90° C / 0.5h)	921 ppm	426 ppm

- VOC emissions reduced by approximately 50%

Foam Physical Properties – TDI technology

VW specification, TL 524 97 (index 100)

33LV /BL11	pphp	0.20/0.10	
NE1070/NE210	pphp		0.40/0.40
DC6070	pphp	0.8	0.8
Ambient conditions			
Density	$\geq 32 \text{ Kg/m}^3$	33	33
ILD	N	231	171
Compression hardness	KPa	3.7	2.6
Tensile Strength	$\geq 90 \text{ KPa}$	174	135
Elongation at break	$\geq 80 \%$	110	95
Comp. Set (70°C/22hr/50%)	$\leq 10 \%$	8	8
Tear strength	$\geq 200 \text{ N/m}$	349	265
Heat Aging (200h/90°C)			
Tensile Strength	$\geq 90 \text{ KPa}$	186	157
Elongation at break	$\geq 80 \%$	126	133
Humid Aging (200h/90°C/100% r.H.)			
Compression hardness deviation („HALL“)	+ 10% to -25%	9	30
Tensile Strength	$\geq 90 \text{ KPa}$	137	47
Elongation at break	$\geq 80 \%$	132	52
Comp. Set („HACS“)	$\leq 15 \%$	14	28

- Physical properties using AP NE catalysts are OK in MDI systems and can meet all OEM specifications with minor adjustments
- Physical properties are deteriorated in TDI systems with all NE type catalysts although AP products provide the least deterioration compared to other competitive products
 - Hardness
 - Humid aged tensile/Elongation
- Major improvements needed to pass OEM specification

New developments to improve physical properties of cold cure foams

Novel Non-Fugitive Blow Catalyst

Dabco NE 300

Dabco NE300

- **Dabco NE300 is a novel reactive and non-fugitive blow catalyst for PU applications**
- **non-emission contributions according to VDA 278**
- **Improved odor from foam according to VDA 270 in comparison to commercially available non-fugitive amine catalysts**
- **Global registration in progress**
 - ✓ Registered in NA
 - ✓ Registered in Europe
 - ✓ Registered in Aus
 - ✓ Registered in Korea
 - Registration expected in Japan in Q4CY07
 - Registration expected in China in Q2/3 CY08

Dabco NE300 Typical Properties

● Appearance liquid	Clear, slightly yellow
● Water Solubility	978 g/l
● Density	0.896 g/cm³
● OH Number	276 mg KOH/g (calculated)
● Boiling Point	279 ° C
● Flash Point	124 ° C
● pH value	11.9
● Viscosity	9.2 mPas / 25°C

Dabco NE300 vs. Dabco NE 210 – MDI technology

NE1070	NE210	NE300
0.60	0.60	-
1.00	-	0.15

- Novel non-fugitive blow catalyst Dabco NE300 provides improved blow activity in comparison to Dabco NE210

Dabco NE300- Physical Properties in MDI

33LV	NE1070	BL11	NE300	40% CLD	HALL	HACS	HA- Tensile	HA- Elongation
				KPa	%	%	KPa	%
0.40	-	0.20	-	11.1	-10	10	159	85
0.40	-	-	0.25	10.5	-14	11	161	94
-	1.20	0.15	-	11.9	-15	19	168	102
-	1.20	-	0.20	11.3	-18	20	154	104

- Foams were prepared by index 100
- Dabco NE300 showed low impact on humid aged physical properties

Odour Test – VDA 270

Conditions	MDI-Foam		TDI-Foam	
	Commercially available reactive blow catalyst	Dabco NE300	Commercially available reactive blow catalyst	Dabco NE300
23°C / 24 h	2.0	1.5	2.5	2.5
40°C / 24 h	3.0	2.5	3.0	3.5
80°C / 2 h	4.0	3.0	4.0	3.5
	Foams contained additional 1.2 pphp NE1070		Foams contained additional 0.7 pphp NE1070	

- **Benchmark**
 - 1 - imperceptible
 - 2 - perceptible, undisturbing
 - 3 - clear perceptible, undisturbing
 - 4 - disturbing
 - 5 - strong disturbing
 - 6 - intolerable

Dabco CL420

A novel cross-linker to improve
physical properties

New crosslinker - Dabco CL420

- **Zero amine emission catalyst package**
NE1070/NE210 based foam may need further improvement of physical properties
 - **Especially in TDI rich foams**
- **Dabco CL420 can partially or fully replace DEOA and improve foam physical properties such as humid aged properties such as hardness, HA tensile, HA elongation HACS...**

Dabco CL420 in TDI system

33LV /BL11	pphp	0.32/0.08		
NE1070/NE210	pphp		0.38/0.45	0.38/0.45
DC5169/5164	pphp	0.8	0.8	0.8
DEOA-LF	pphp	1.76	1.76	
Novel Crosslinker CL420				0.50
Physical Properties				
Density	Kg/m ³	32	31	31
Airflow.	SLM	1.9	2.1	2.0
ILD, 25%; ILD 65%	N	93/278	98/277	103/295
ILD, 25%, return	N	79	85	86
Elongation at break	%	104	99	110
Tensile Strength	KPa	115	125	117
Comp. Set (70°C/22hr/50%)	%	6	9	9
Tear strength	N/m	220	214	238
HA-Elongation, DC	%	149	Deteriorated	156
HA-Elongation, VW	%	133	67	132
HA-Tensile, DC	KPa	23	Deteriorated	19
HA-Tensile, VW	KPa	119	58	103
Comp. Set („HACS“)	%	18	28	11

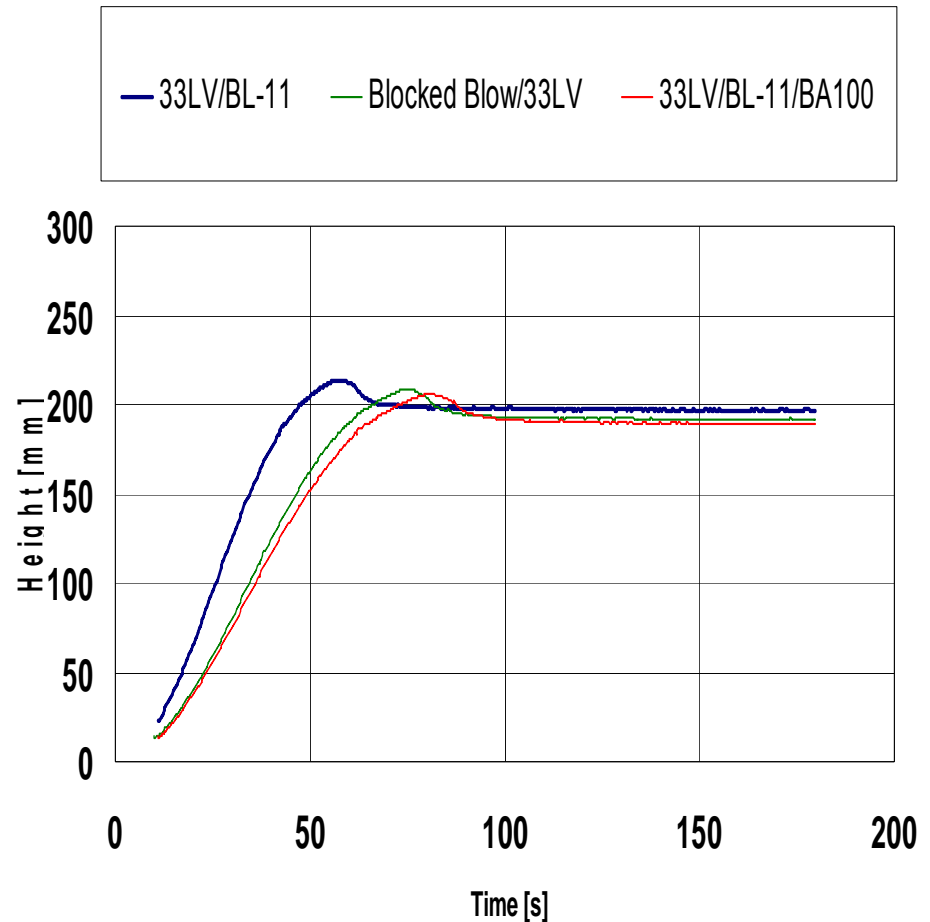
Dabco BA100

Dabco BA100

- **Dabco BA100 is a reactive and non-emission blocking agent for PU applications**
- **Dabco BA100 can delay cream time and improve liquid flow when used in combination with either conventional or non-emission catalysts**
- **non-emission contributions according to VDA 278**
- **Can also improve humid aged physical properties**
- **Safety data**
 - **No risk (R) and safety (S) phrases.**
 - **Non corrosive**

Blocking Standard Catalysts in T/M

33 LV		0.40	0.40	0.40
BL 11		0.20		0.20
Blocked BL 11 Catalyst			0.31	
Dabco BA100				0.25
Start time	[s]	12	13	13
Rise time	[s]	60	70	74
Density	[kg/m ³]	43	45	46



Non-Emission Family of Additives for Flexible Molded Applications

Gel Catalysts

Dabco NE1070

Blow Catalysts

Dabco NE210

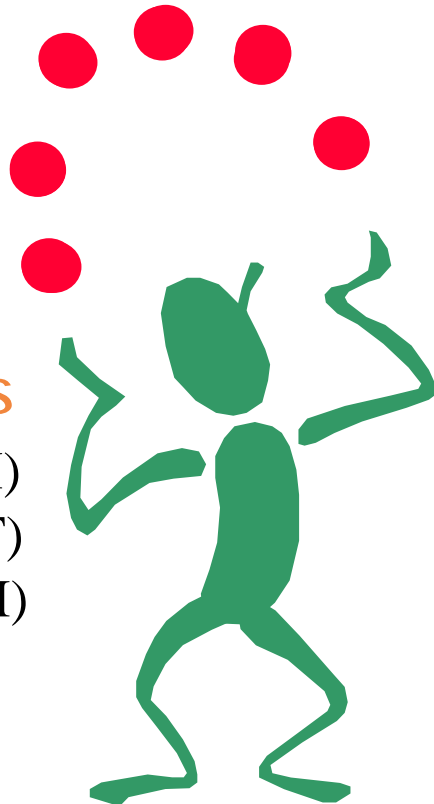
Dabco NE300

Silicone Surfactants

Dabco DC6070 (TDI)

Dabco DC2585 (M/T)

Dabco DC2525 (MDI)



Surface Cure Catalysts

Polycat 15

Polycat 58

Dabco MP602

Blocking Agent

Dabco BA100

Novel crosslinker

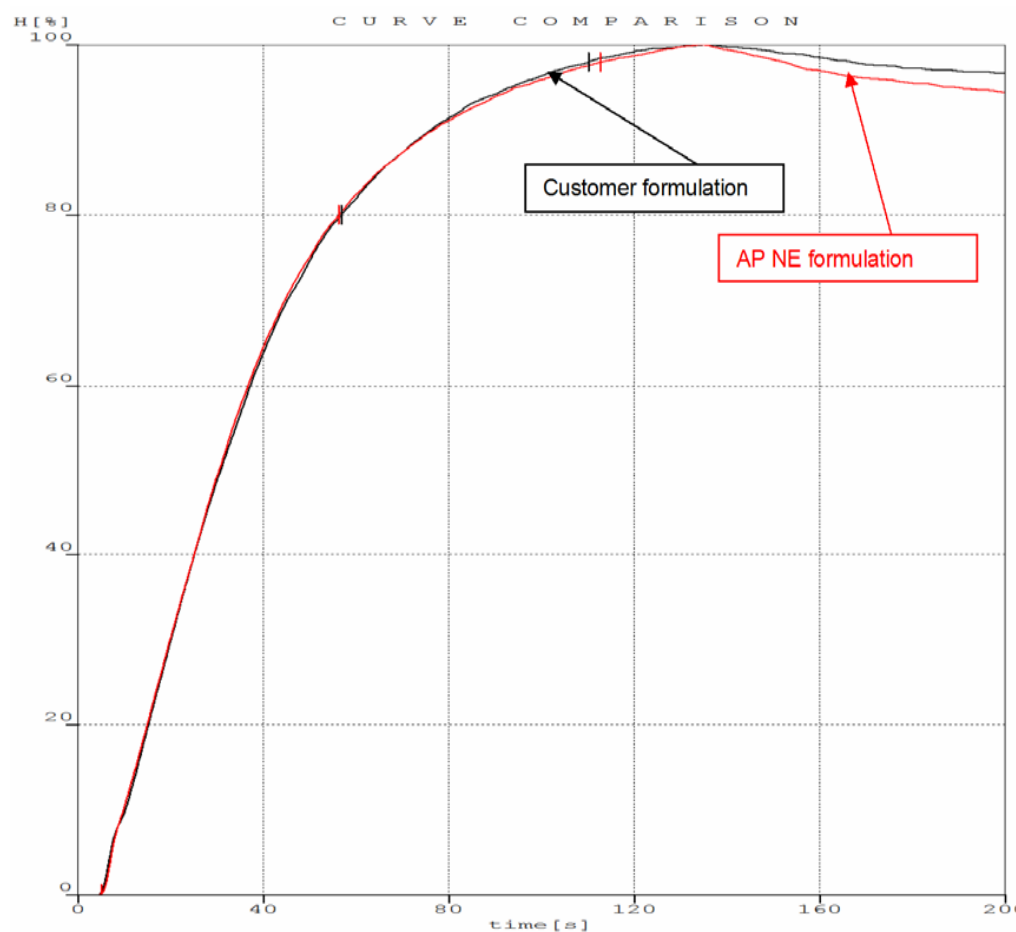
Dabco CL420

Experience in Asian T/M Formulations

NE1070/NE210/MP602 in T/M headrest system

- Meet similar reaction profiles with similar TFT
- NE1070/NE210 alone may result in longer demould times compared to standard catalysts
- MP602 Co-catalyst can decrease demould times to be again equal to standard catalyst systems

	Customer formulation	AP
Polyols	100	100
Dabco CL420		0.30
Cat. mixtures	2.0	
Dabco NE1070		0.40
Dabco NE210		0.40
Dabco MP602		0.10
Competitive ssf.	0.70	
Dabco DC 6070		0.70
Water	3.50	3.50
TM20	100/36	100/36
Test conditions: a) temperature of raw materials, 28°C; b) Mixing rate, 1500RPM; c) Mixing time, 5s		
G/T, s	68	69
R/T, s	131	128
TFT, s	420	422
Foam quality	good	good



NE1070/NE210/MP602 in T/M headrest system

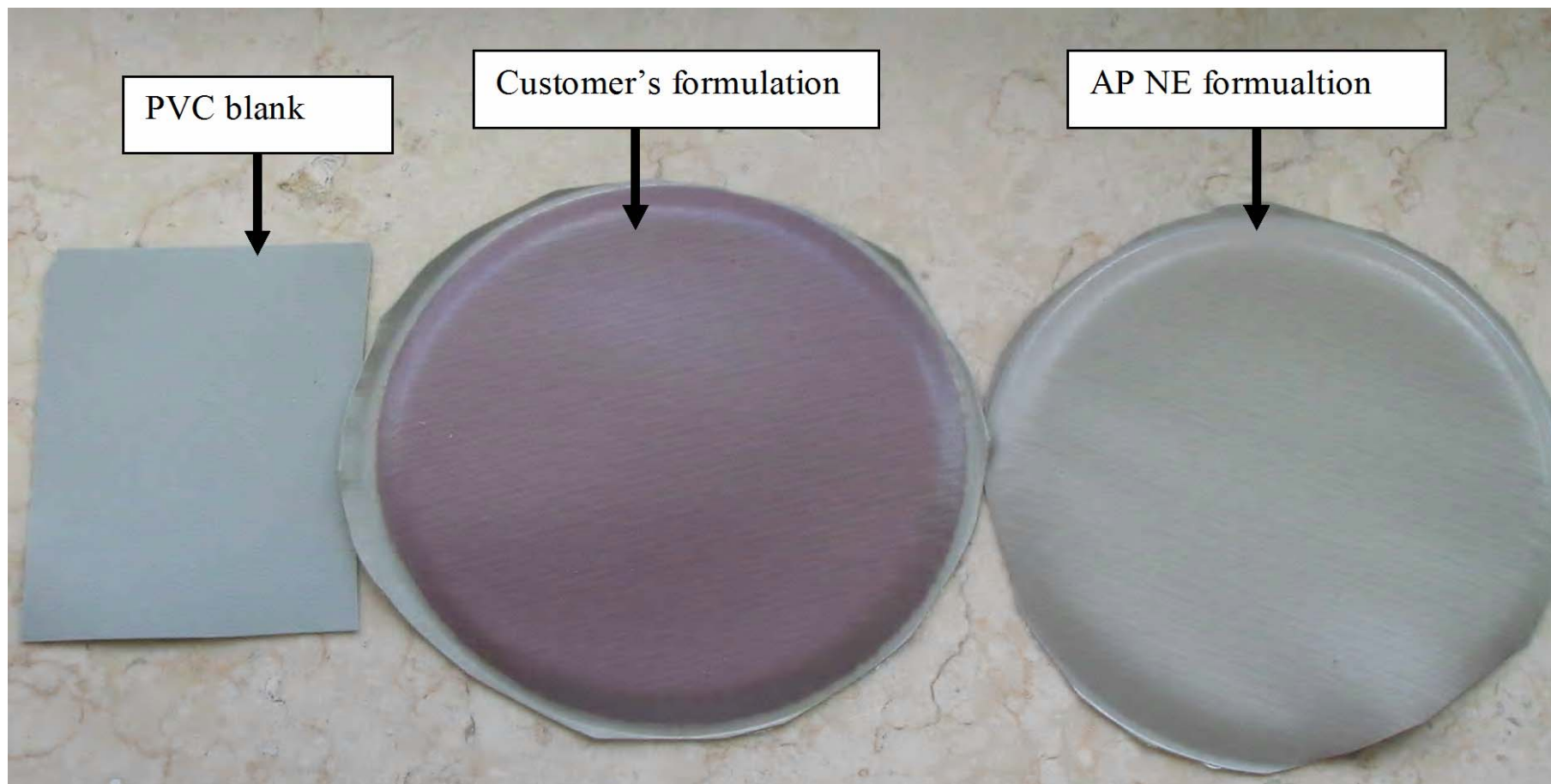
		Customer formulation	AP NE formulation
Ambient			
Density		kg/m3	
		44.7	43.4
ILD	25%ILD	N	
		141	155
ILD	50%ILD	N	
		345	368
Tensile		MPa	
		124	151
Elongation		%	
		92	102
Compression set (70C/22hr/50%)		%	
		11	10
Tear		N/m	
		275	323
Humid aging (22hr/ 50C/ 95% R.H)			
Tear		N/m	
		289	326
Tensile		MPa	
		129	144
Elongation		%	
		80	95
Comprssion set (70C/22hr/50%)		%	
		13	12

➤ **Maintain similar physical properties.**

Test conditions:

1. Temperature of raw materials: 25° C
2. Mold size: 400X400X100 mm
3. Mold temperature: 65° C
4. Demolding time: 3min.

NE1070/NE210/MP602 in T/M headrest system



Remark: a. both test foam are taken from customer's production line;

b. PVC staining test method: **PV 3937(100°C/72hr.)**

c. NE catalysts package: NE1070(0.40)/NE210(0.40)/MP602(0.10)

d. NE formulation can pass the VW. PVC standard.

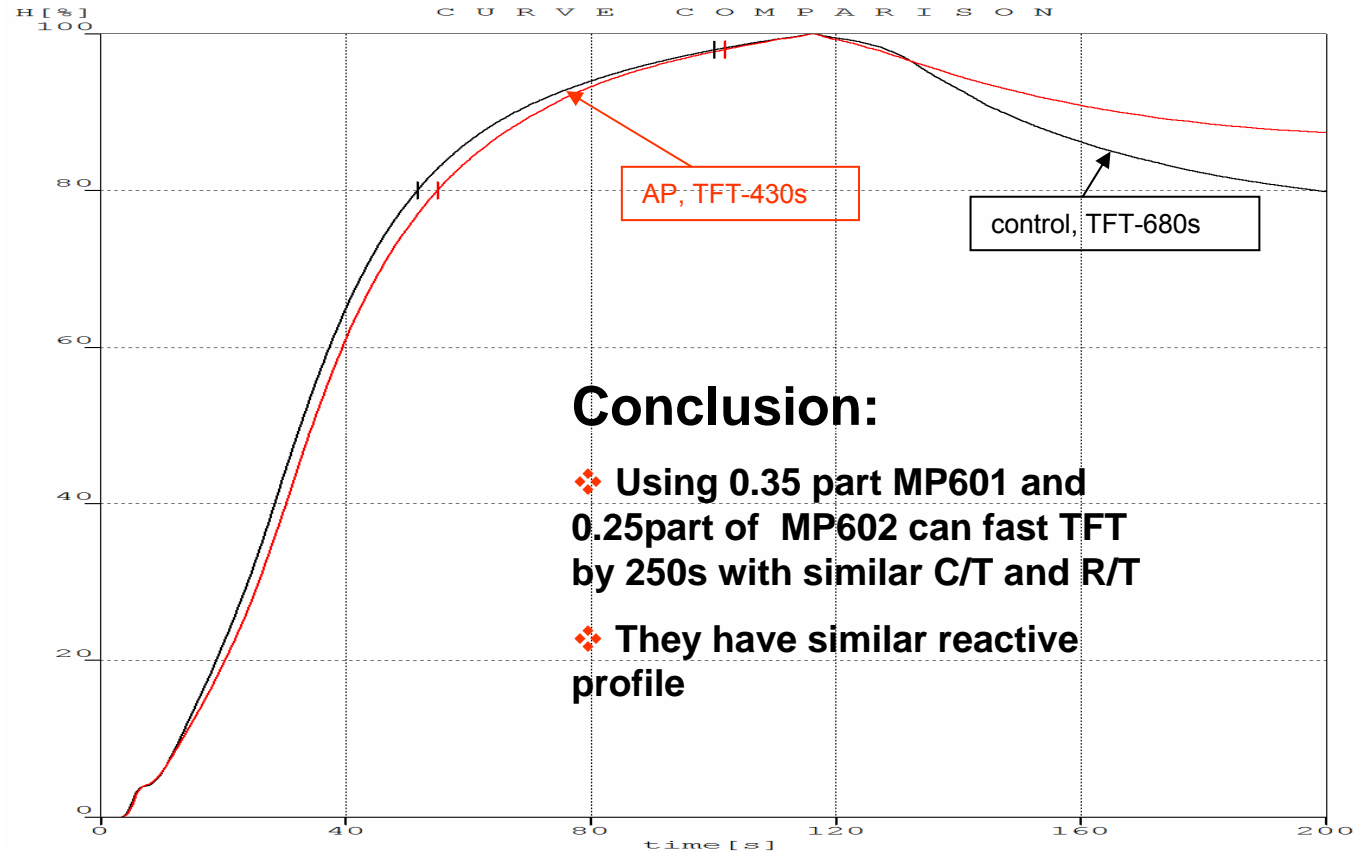
Catalysts for Fast Demolding

Background

- **Basing on general T/M seating system, Air Products (abbr. as AP) develop two catalysts to speed up the demold time, they are helpful for seating producers to shorten the cycling time of production line and increase the plants' productivity**
- **The two catalysts are:**
 - Dabco MP601: delayed action balanced blow gel catalyst package**
 - Dabco MP602: delayed action reactive catalyst that speeds up demold time, and is truly non-fugitive**

Lab Tests (ROR of cup foam)

	control	AP
polyols	100	100
DEOA-LF	0.5	0.5
Cat-A	0.20	
Cat-B	0.20	
33LX	0.10	
MP601		0.35
MP602		0.25
DC6070	1.00	1.00
H2O	3.90	3.90
Mixing ratio (P/I)	100/44	100/44
C/T, s	8	8
G/T, s	91	66
TFT, s	680	430
R/T, s	116	116
Foam quality	Good foam	Good foam



Remark:

Cat-A: A competitive delay balance catalyst.

Cat-B: A competitive delay blow catalyst.

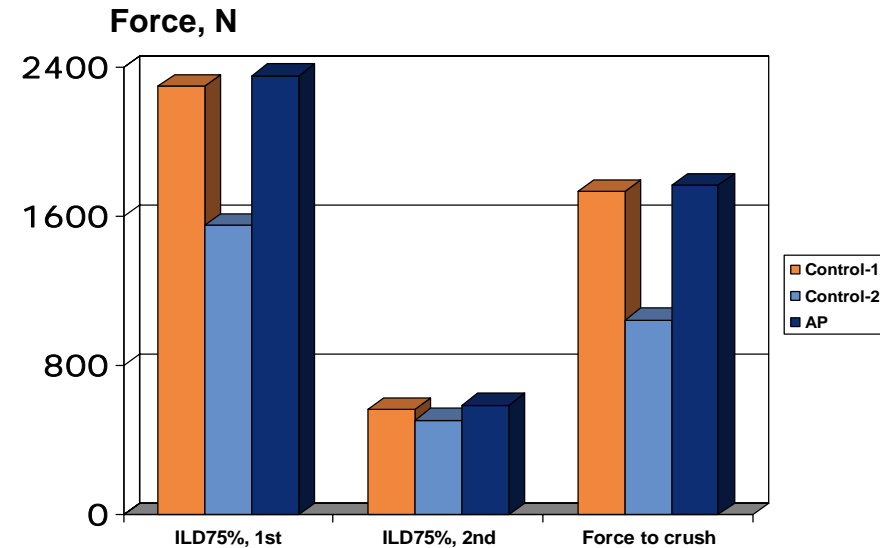
P: means mixture of polyols and other additives such as ssf. 、cat.s and water

I: means T/M 20 (TDI/MDI=80/20) from BASF

Polyols: are mixture of base polyol and polymer polyol.

Lab Tests (mold tests-indentation hardness method)

	Control-1	Control-2	AP
polyols	100	100	100
DEOA-LF	0.5	0.5	0.5
Cat-A	0.2	0.2	
Cat-B	0.2	0.2	
33LX	0.1	0.10	
MP601			0.35
MP602			0.25
DC6070	1	1	1
H2O	3.9	3.9	3.9
TM20	100/44	100/44	100/44
Test condition: Raw materials----- 25° C; Mold size----400X400X100mm; Mold temperature---65 ° C; ILD is tested in 1min later after demolding.			
Demold time, min	4.5	3.5	3.5
Wt.,g	728	730	738
ILD 75%, 1st, N	2296.02	1553.33	2356.24
ILD 75%, 2nd, N	563.97	507.9	588.04
Force to crush $\delta = 1^{st} - 2^{nd}$, N	1732.05	1045.43	1768.2
Foam quality	Foam have Some expanding but no collapse Good surface	Foam is soft, some place have little Distortion Good surface	Foam have Some expanding but no collapse Good surface



Conclusion:

- We can see the cell open property from the $\delta (= \text{ILD75\%, 1}^{st} - \text{ILD75\%, 2}^{nd})$
- We can see the curing property from the value of ILD75\%, 2^{rd} .
- According to the cell open and curing properties, we think the AP formulation can fast demold by 1min. comparing with control formulation. .

Lab Tests (physical properties tests)

	Control-1	AP
Ambient conditions		
Density , Kg/m ³	45.5	46.1
ILD, 25%; ILD 50%, N	200/412	192/391
Elongation at break, %	110	101
Tensile Strength, MPa	183	177
Comp. Set (70°C/22hr/50%), %	6.1	7.0
Tear strength, N/m	371	397
Humid Aging (22h/50C/95% R.H.)		
HA-Elongation, %	100	110
HA-Tensile, Mpa	174	193
HA-Tear , N/m	363	315
HA-Comp. Set, %	10.7	8.4

Conclusion:

➤ AP formulation which use MP601 and MP602 also have similar physical properties as control.

Conclusion

- ❖ In general T/M seating system, AP's two new catalysts-Dabco MP601 and MP602 can help to fast demold comparing with general catalysts-Cat-A、Cat-B and 33LX;
- ❖ When using 0.35pphp Dabco MP601 and 0.25pphp Dabco MP602 (total,0.60) to replace 0.20pphp Cat-A,0.20pphp Cat-B and 0.10pphp 33LX(total,0.50), the demold time can be shortened from 4.5min. to 3.5 with similar reactive profile .
- ❖ Dabco MP601 is a delayed balance catalyst, have better processing properties Dabco MP602 is a delayed reactive catalyst and speed up the demold time with less effecting the cream time, and truly non-fugitive.

Thank you

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