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HCFC Phase-out in China for Rigid Polyurethane Foam Applications

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Montreal, Canada
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HCFC Phase-out Schedule – Article 5 Parties

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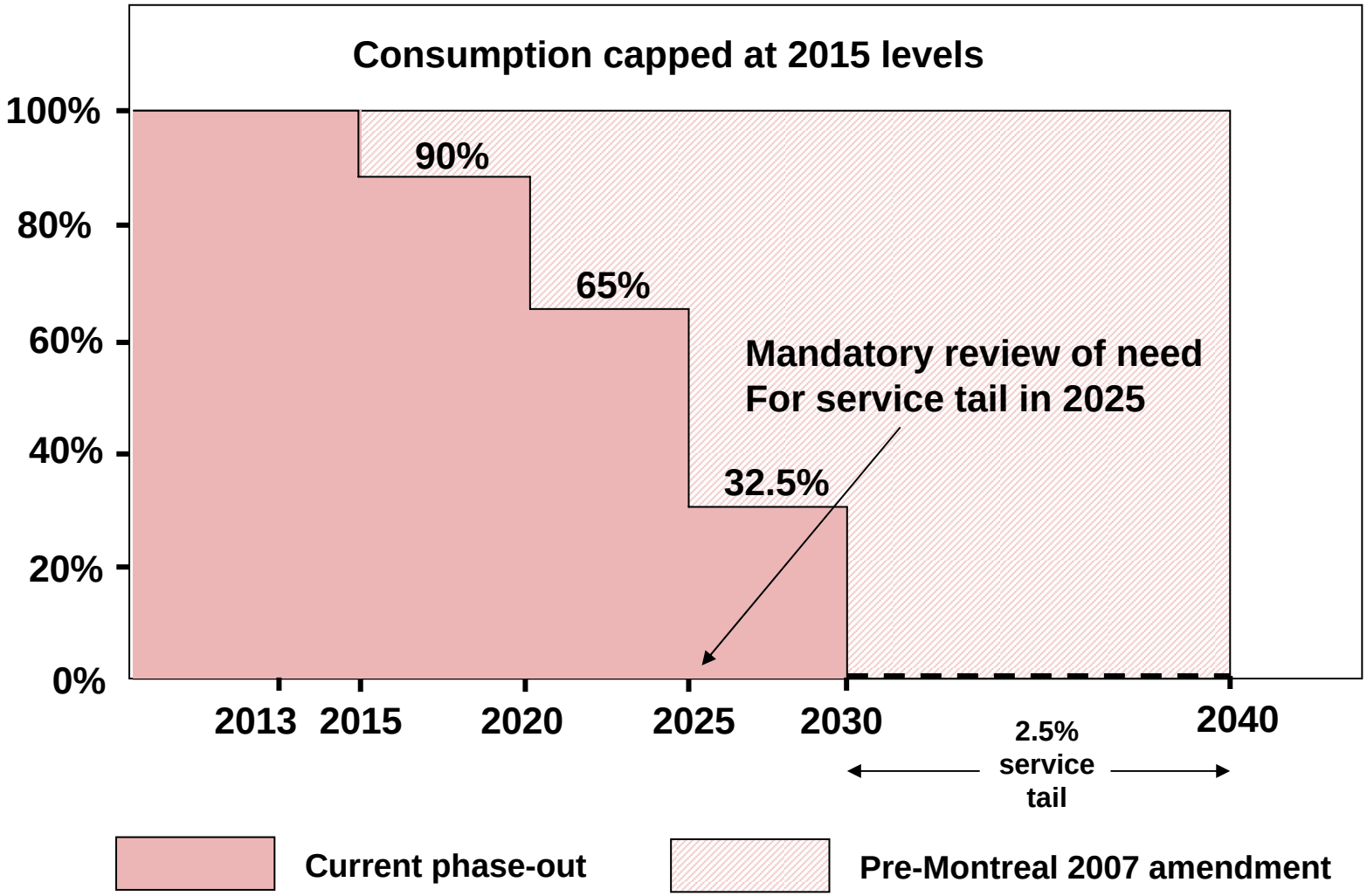

Polyurethane – a Versatile Material

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Blowing Agents for Polyurethane Rigid Foam

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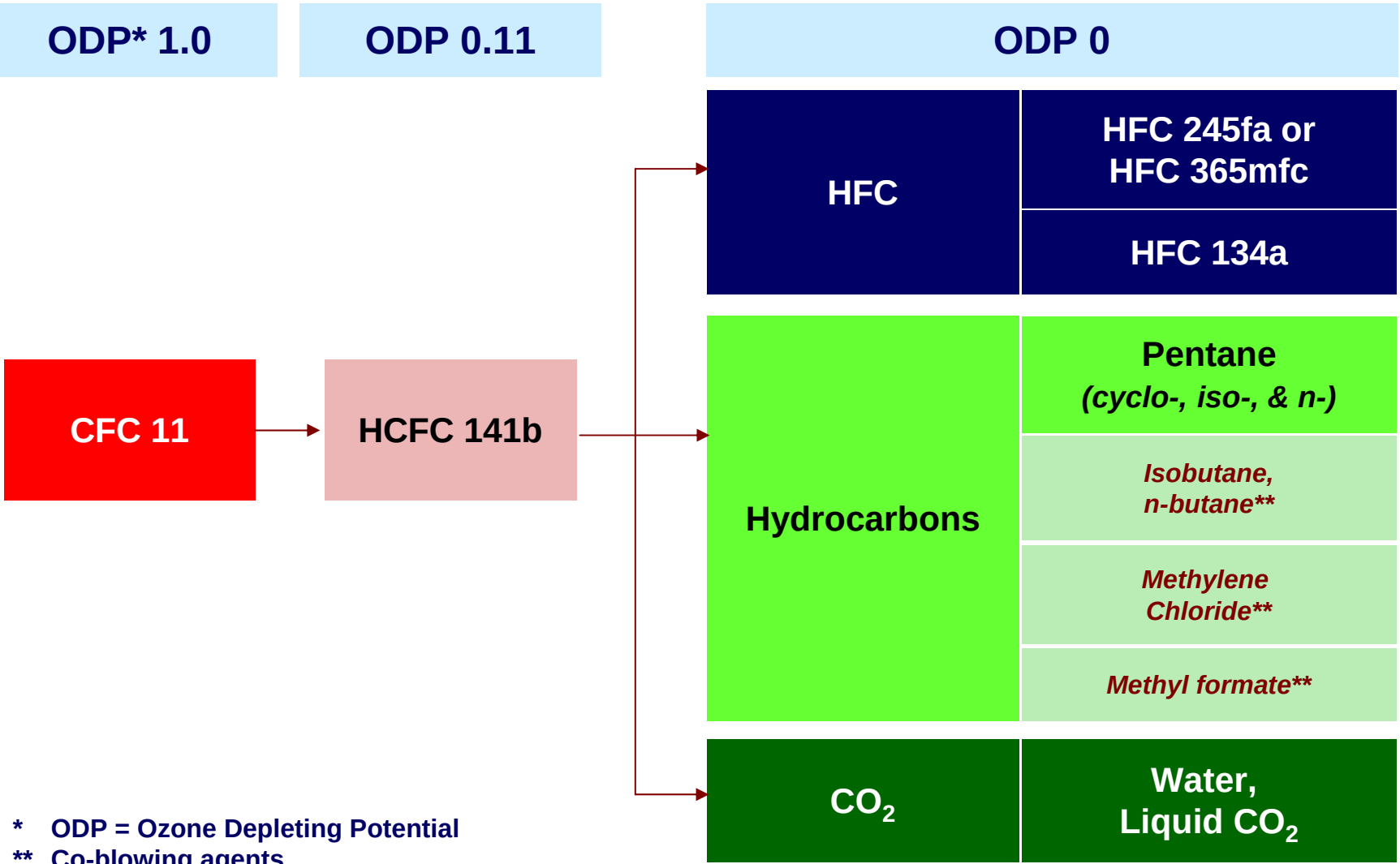

* ODP = Ozone Depleting Potential
** Co-blowing agents

Properties of Major Blowing Agents

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Blowing agent	M.W.	Boiling point (°C)	Density (g/cm^3) @ 20°C	Gas λ (mW/mK) @ 10°C	Price in March 08 (RMB/Kg)
CFC11	137	23.8	1.4940	7.4	Phased-out
HCFC141b	117	32	1.2500^{10}	8.8	11.6
n-pentane	72	36	0.6262	14	10.5
iso-pentane	72	28	0.6201	13	10.5
c-pentane	70	50	0.7457	11	13.5
iso-butane	58	-11.7	0.5512^{25}		22.5
HFC245fa	134	15.3	1.3200^{25}	12.2@25°C	70.0
HFC365mfc	148	40.2	1.25	10.6@25°C	108.0
HFC134a	102	-27		12.4	38.0
H_2O/CO_2				16.6 @ 25°C	~0

Snapshot of Manufacturing of 141b in China

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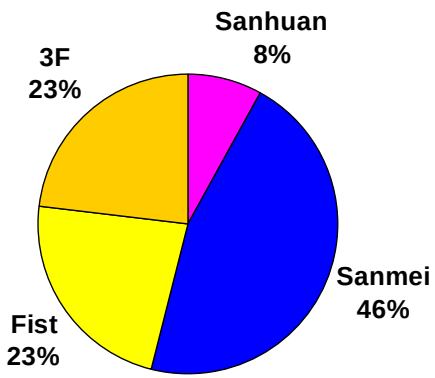
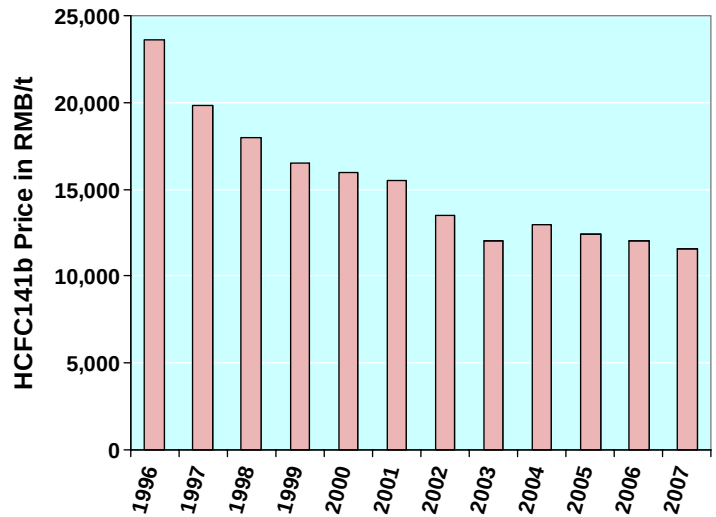
- Currently 4 manufacturers in China
- Concentrated in Eastern China
- Total production in 2007: 80kt
- Sanmei is the largest producer with nearly half of the market share
- 141b price has been falling over the last 10 years

141b manufacturers in China





Overview of Alternatives to 141b for Rigid Foam in China

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	HFC	Hydrocarbon	Water
Appliances			
Water heaters			
Reefer containers			
Sandwich panels			
Pipes			
Spray			
Structural foam			

Commercialized Being tested Not an option in a short term

Appliances: Pentanes Dominate in China

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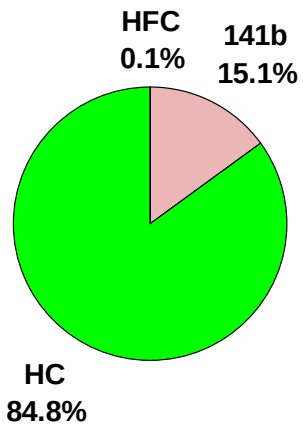
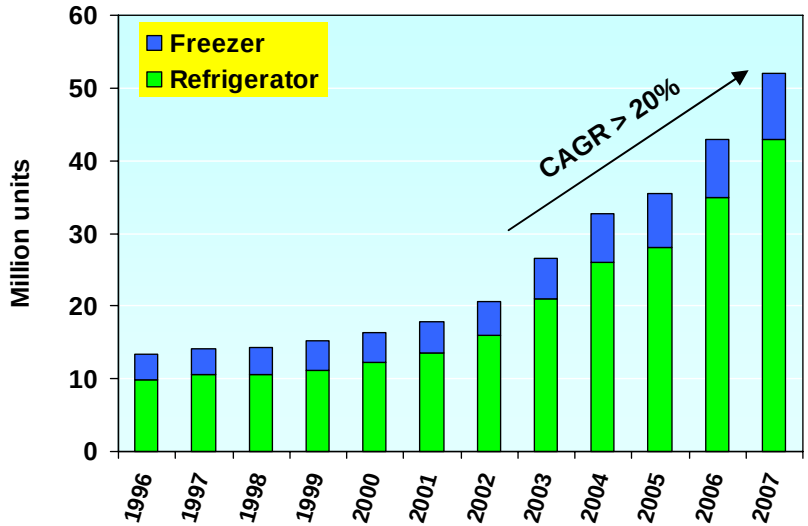
- Total output was 52 million sets in 2007 - 60% of global output
- Accounted for 50% of total PU rigid foam in China
- Hydrocarbon (HC) widely used
  - c-pentane
  - c/i-pentane
- Small factories still using 141b due to high conversion costs
- Major challenges in 141b phase-out
  - HCs: high capital investment; higher thermal conductivity; safety
  - HFCs: significantly higher cost

Blowing agents used in Appliances





Conversion Cost

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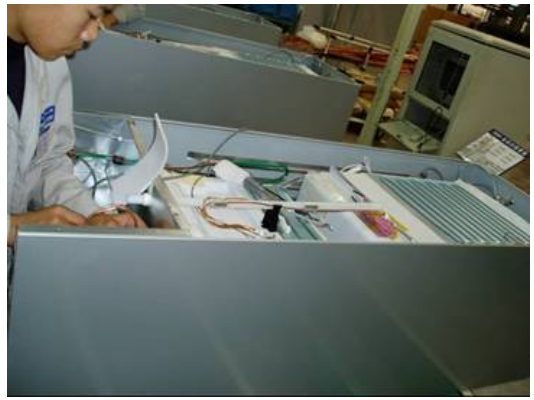
- For a typical refrigerator manufacturing plant with 1m/a capacity
- Converting from 141b to c-pentane

Conversion items	Estimated costs (k Euros)
Pentane storage tank (35m^3)	100
Preblending, an intermediate storage tank, and piping (assuming 200m)	150
Cabinets foaming machines (4)	320
Doors foaming machines (2)	150
Venting system	50
Pentane detection system with detectors, and modification of 40 jigs	100
Total conversion cost	**870**



Reefer Containers: 141b Dominates

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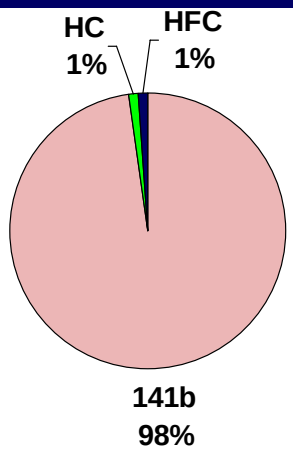
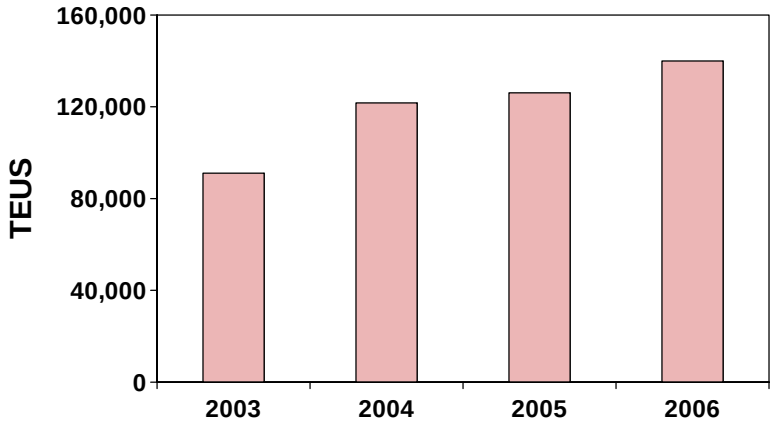
- Almost 100% global reefer containers were produced in China in 2007
- Total PU consumption in 2007: 50kt
- 98% blown with 141b – HFCs and HCs used mainly due to export requirements
- Major challenges in 141b phase-out
  - HFCs: high blowing agent cost, e.g. ca USD720 cost increase per FEU if HFC365mfc / HFC227ea is used
  - HCs: high capital investment; safety

Blowing agents in reefers



Output of reefer containers



Sandwich Panels: 141b and Water Dominate

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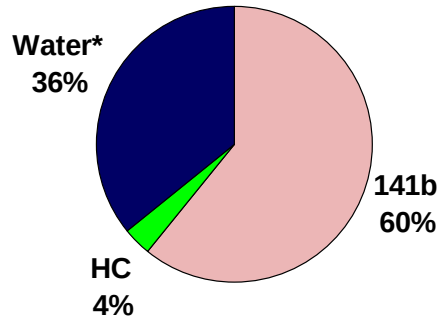
- Total market size: 40kt PU system
- Some continuous panel manufacturers switching to HC and water from 141b
- Almost all discontinuous panel manufacturers are using 141b
- Major challenges in 141b phase-out
  - Water: poor thermal insulation and adhesion
  - HC: high capital investment; safety

Blowing agents in continuous panels

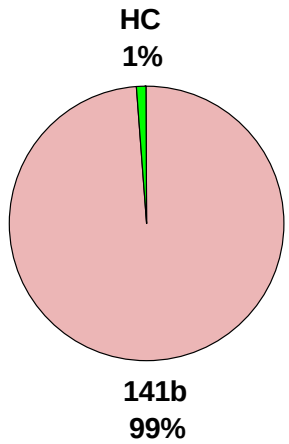


* *Mainly for low density open-cell panels*

Continuous panel

Discontinuous panel

Blowing agents in discontinuous panels



Pipe: 141b and Water Dominate

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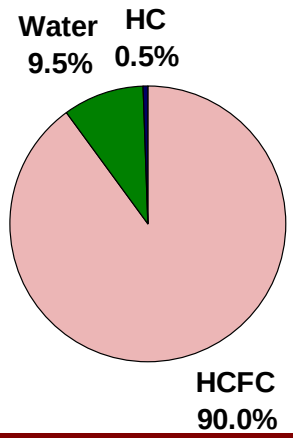
- Pipe consumed 50kt rigid PU foam in 2007
- Water blowing technology accounted for 9.5% - mainly for the district central heating segment
- HC has 0.5% share
- Major challenges in 141b phase-out
  - Water: poor thermal insulation and adhesion
  - HCs: high capital investment; safety

Blowing agents in pipes



Spray Foam: Close to 100% 141b

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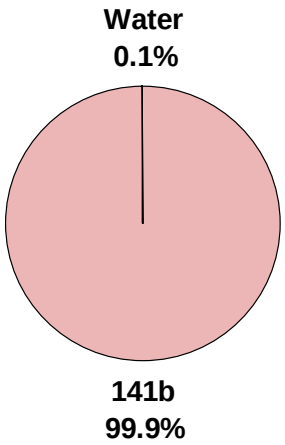
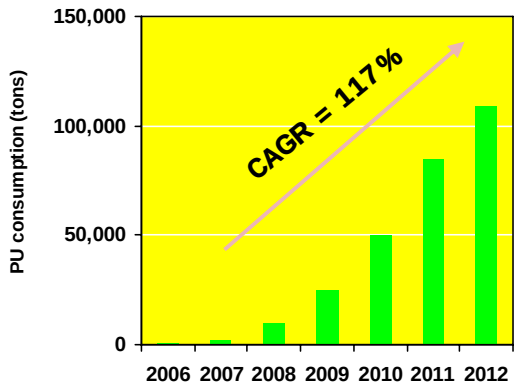
- Market demand in 2007: 60kt PU system
- Main applications: cold storage rooms and residential buildings
- Residential building insulation market: explosive growth - as the Chinese government implements stricter energy saving regulations
- 141b is used – water technology only used in open cell foam for some niche applications
- Major challenges in 141b phase-out
  - HC will not be an option due to safety concerns (safety measures difficult to implement in China!)
  - Water: poor thermal insulation and adhesion
  - HFC is 5-8 as times more expensive *cf* 141b

Beijing Olympic Stadium
insulated with Huntsman's PU system

Blowing agents in spray foam



Spray foam for residential building insulation



Standard Chartered Bank, Pudong
insulated with Huntsman's PU system

Huntsman's Strong Commitment to China

1st foreign TS center
1992

1st MDI plant proposed
1995

1st foreign system house
1996

1st bulk delivery supplier
1997

- Huntsman have many 1st mover advantages
- Huntsman pioneered the HCFC141 phase-out
  - 1st to introduce c-pentane blowing technology and the patented c/i-pentane blowing technology to China in 1995

MDI Plant's
Commercial operation 2006
2006

ATC Shanghai 2008
2008

Conclusions

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- HC is the preferred blowing technology in the Appliances industry and is entering other applications
- 141b is still the dominant blowing agent for other rigid foam applications
- Adoption of HFCs is limited due to its high cost
- CO_2 blowing technology is limited by its poor adhesion and thermal insulation property
- Huntsman is leading in the development of blowing agent technologies in China

Thank You !

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