



Thawing the Challenges Associated with Pure 4,4'-Methylenediphenyl Diisocyanate

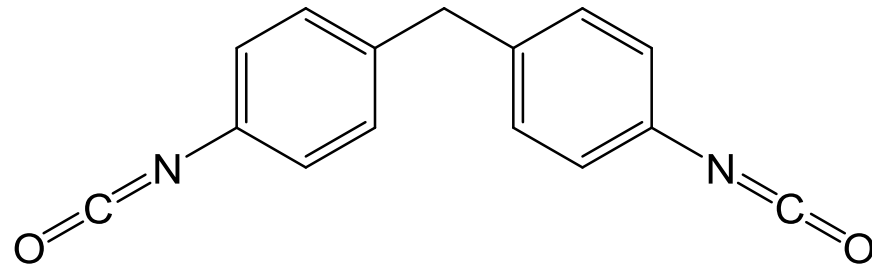
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Outline

- Background: 4,4'-Methylenediphenyl diisocyanate (MDI) advantages and challenges
- ISONATE™ 128 Modified MDI
- Performance comparison
- Conclusions

4,4'-Methylenediphenyl Diisocyanate Background

- 4,4'-MDI is valued for its reactivity and the mechanical properties imparted by its symmetry



4,4'-Methylenediphenyl diisocyanate

- Common applications utilizing 4,4'-MDI include: coatings, elastomers, prepolymers, and thermoplastic polyurethanes

Challenges Associated with 4,4'-MDI

- The challenges associated with pure 4,4'-MDI are related to its melting point and tendency to dimerize

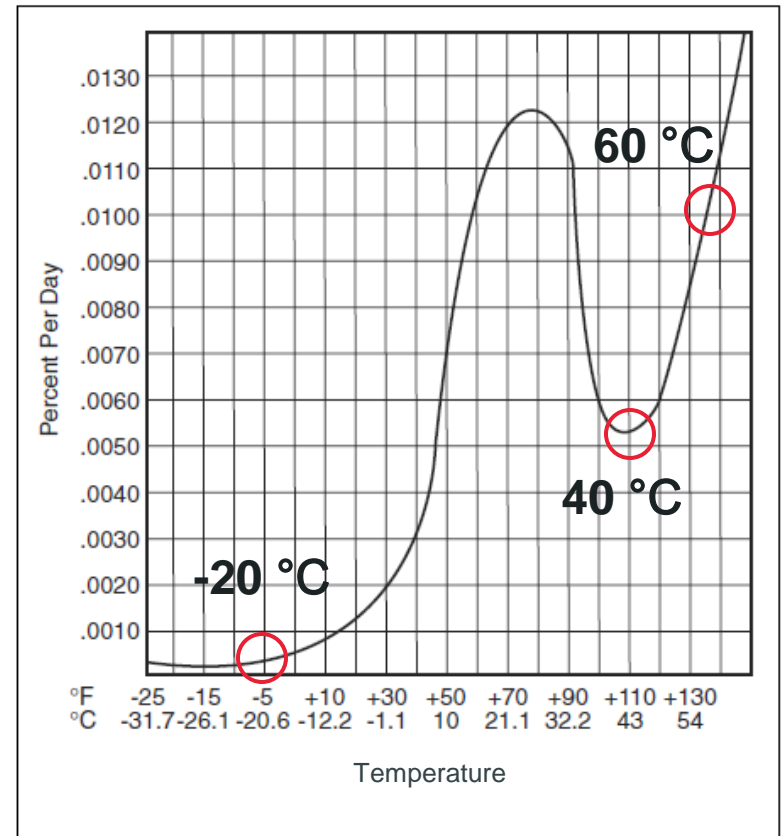
- 4,4'-MDI melts at 38-42 °C (100-108 °F)

- Rate of dimerization is temperature dependent

-20 °C	4 ppm/day
40 °C (mp)	55 ppm/day
60 °C	>100 ppm/day

- Dimerization occurs in the solid state***
 - Sub-zero temperatures required to decrease rate of dimerization below 10 ppm/day

Rate of Dimer Formation



Challenges Associated with 4,4'-MDI

- The high melting point (38-42 °C) requires additional infrastructure and capital for storing, handling, and processing
- The rate of dimerization at practical temperatures leads to significantly diminished shelf-life

- Dimerization results in product degradation with respect to clarity and performance
- Pure 4,4'-MDI is delivered in two forms—molten or frozen
- Molten shipments have < 1mo. shelf-life
- Frozen shipments must be thawed and then promptly consumed

Temperature °C(°F)		Storage Life days
-17.8	(0)	300
-12.2	(10)	210
4.4	(40)	68
10	(50)	33
40.6	(105)	31
48.9	(120)	28

■ ISONATE™ 128: Liquid-stable Modified MDI with High 4,4'-MDI Content

- Enable access to performance benefits of pure 4,4'-MDI with less demanding infrastructure to handle and process it—
reduced energy and labor costs
- Develop a liquid product with resistance to dimerization at 80 °F and a shelf-life of at least 6 months



Performance Comparison of Pure 4,4'-MDI vs. ISONATE™ 128 Systems

10 %NCO prepolymers were made with VORANOL™ 223-060LM Polyol.

The prepolymers were then cured at 60 °C using a blend comprising 92% of VORANOL™ CP6001 Polyol and 8% 1,4-butane diol in the presence of 200 ppm of dibutyltin dilaurate.

	Tensile Strength (psi)	Elongation %	Modulus (psi)	Shore A Hardness
ISONATE™ 125M Prepolymer System	1,190	994	300	57
ISONATE™ 128 Prepolymer System	1,250	922	356	54

Conclusions

- Transportation and processing challenges associated with pure 4,4'-MDI inhibit its widespread use despite desirable properties
- Dow has developed a new isocyanate which maintains liquid stability at 80 °F and is more resistant to dimerization
 - **6-months shelf-life at 80 °F compared to 30 days for pure 4,4'-MDI**
 - **Reduced energy costs for storage and handling**
- ISONATE™ 128 demonstrated very similar mechanical performance to pure 4,4'-MDI