

# Influence of Processing Pressure Differential and Mixing Module Configuration on Volumetric Ratio and Physical Properties of a Spray Polyurea Elastomer.

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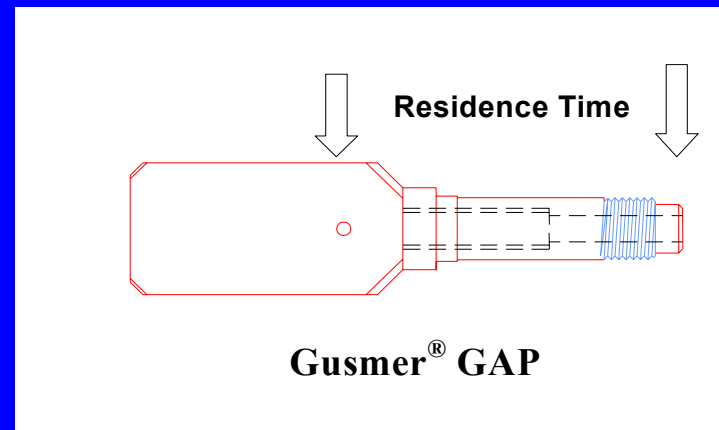
# 1966 Shelby Cobra Model

# Mixing Process

- **Macromixing:** (ex., 635  $\mu\text{m}$  to 100  $\mu\text{m}$ )
- **Micromixing:** (ex., 100  $\mu\text{m}$  to 1  $\mu\text{m}$ )
- **Diffusion:** (ex., 1  $\text{nm}$ )
- **Mixing Efficiency**
  - Predictions: Reynolds number
  - Measurement: Tensile & Elongation

# Residence Time

- Time  $\sim 0.7 - 1.8$  milliseconds

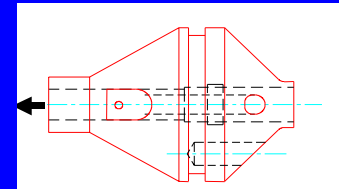


- Majority of diffusion occurs outside of the mixing chamber

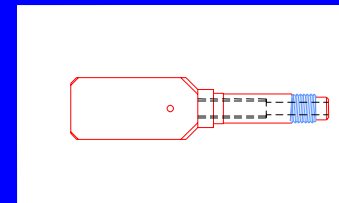
# Application Equipment



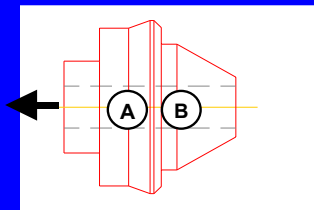
**Figure 1: Gusmer® H-20/35 proportioning unit.**



**Figure 2: GX-7 Direct Impingement spray gun and mixing module (courtesy of Gusmer®).**

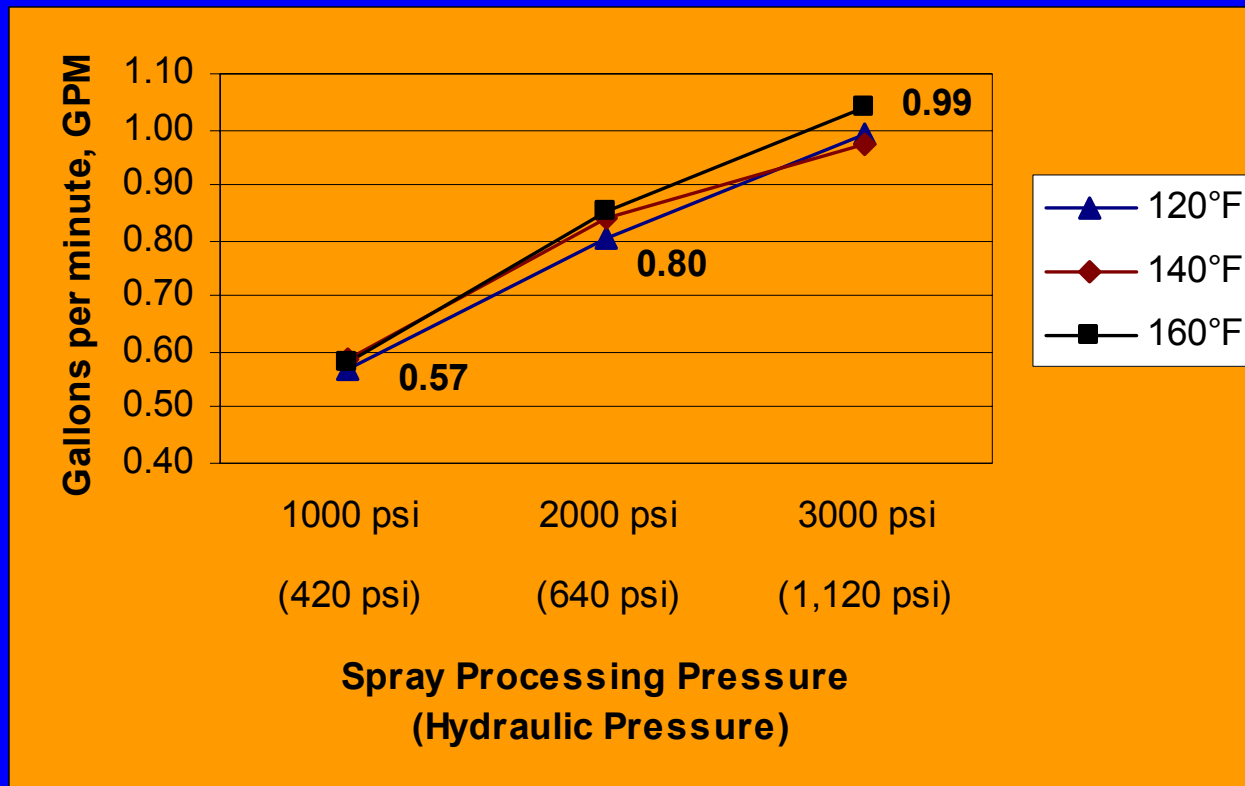


**Figure 3: GAP spray gun and mixing module, 00/01 (courtesy of Gusmer®).**



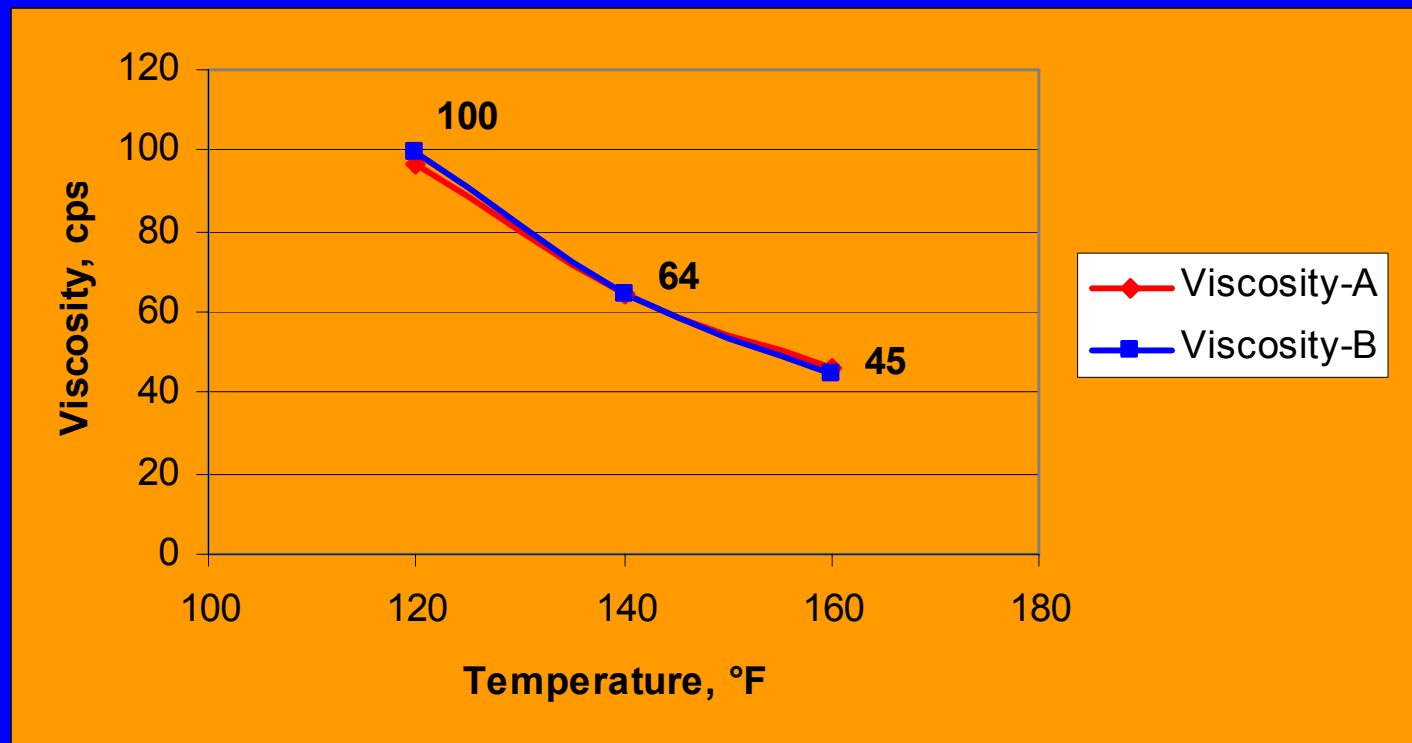
**Figure 4: GX-7 400 series spray gun and 452 / 453 mixing modules (courtesy of Gusmer®).**

# Reynolds Number



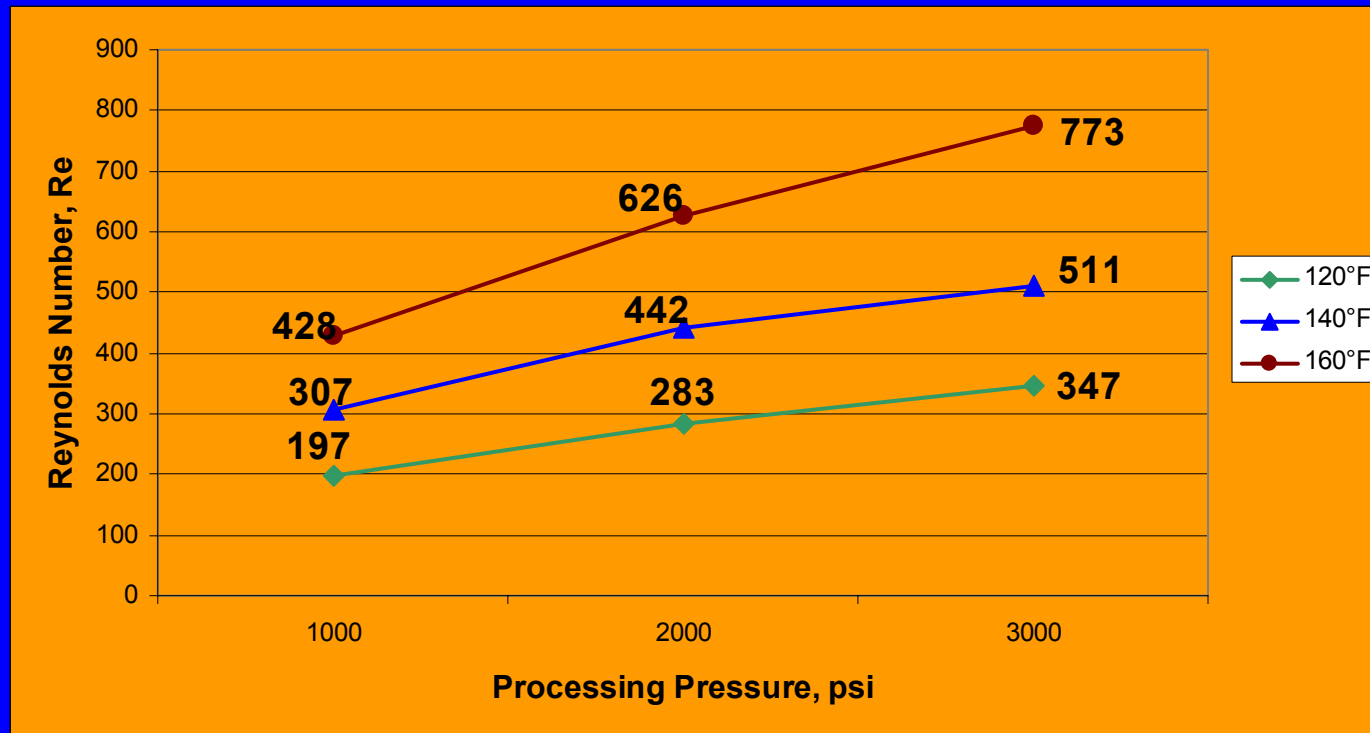
$$Re = 4 \rho Q / \pi \mu d$$

# Reynolds Number



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# Process Parameter

Spray Processing Temperature (Primary and Hose)	Spray Processing Pressure (Hydraulic pressure)			Average Tensile Strength (1000-3000 psi)	Std. Dev. (1000-3000 psi)
	1000 psi (420 psi)	2000 psi (640 psi)	3000 psi (1,120 psi)		
120°F	1704	1922	2150	1925	223
140°F	1582	2032	2103	1906	283
160°F	1736	2126	2274	2046	278
Average Tensile Strength(120-160°F)	1674	2027	2176		
Std. Dev. (120-160°F)	81	102	88		

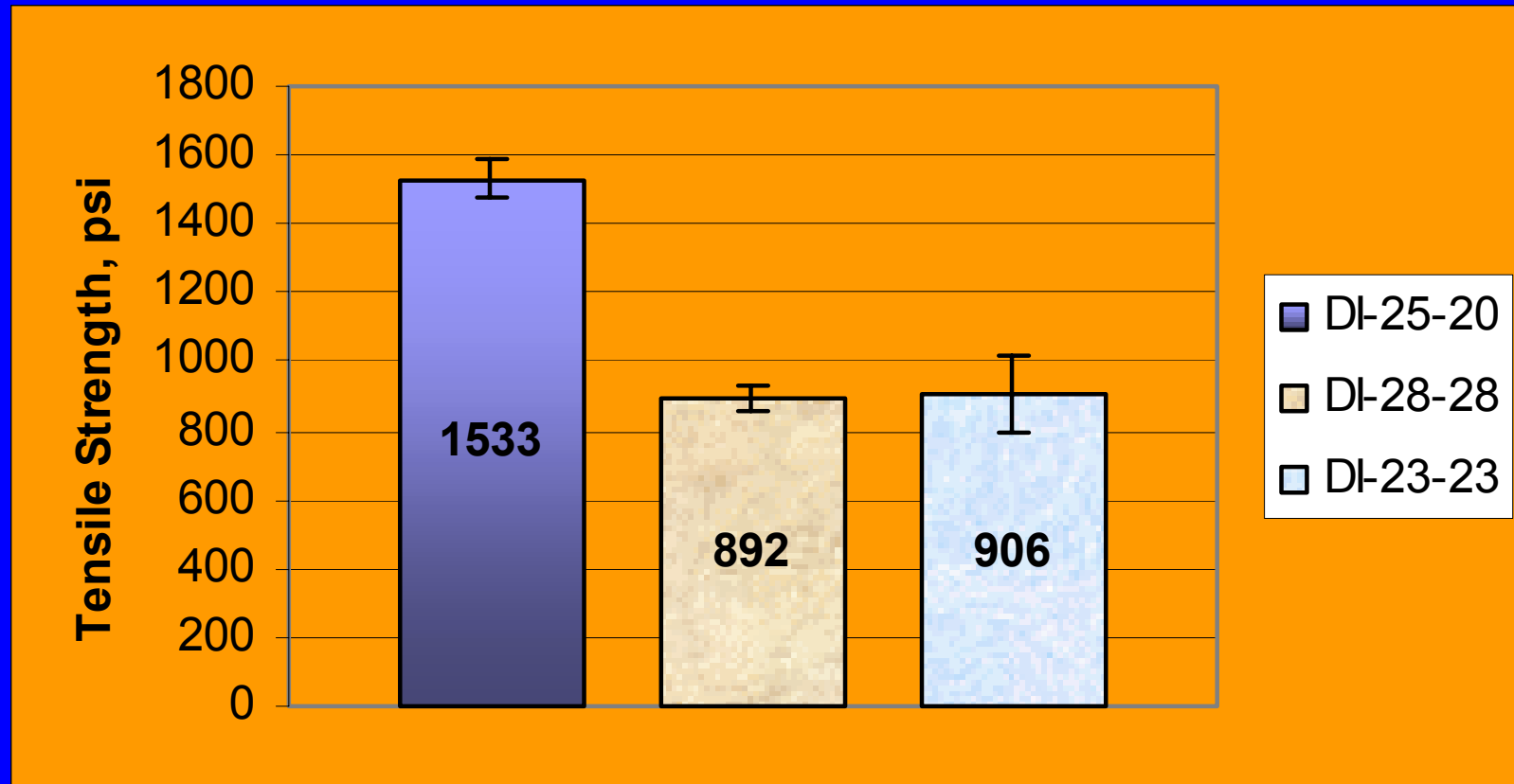
# Gun Configuration

- “Will it work?”
- Manufacturer’s is responsible for defining process parameters and spray gun configuration.
- Just because it sprays, doesn’t mean optimum mixing efficiency is achieved, or the specified properties will be realized.
- Mixing efficiency is influenced by:
  - Nozzle diameter
  - Nozzle orientation
  - Mixing chamber geometry

# Pressure Differential

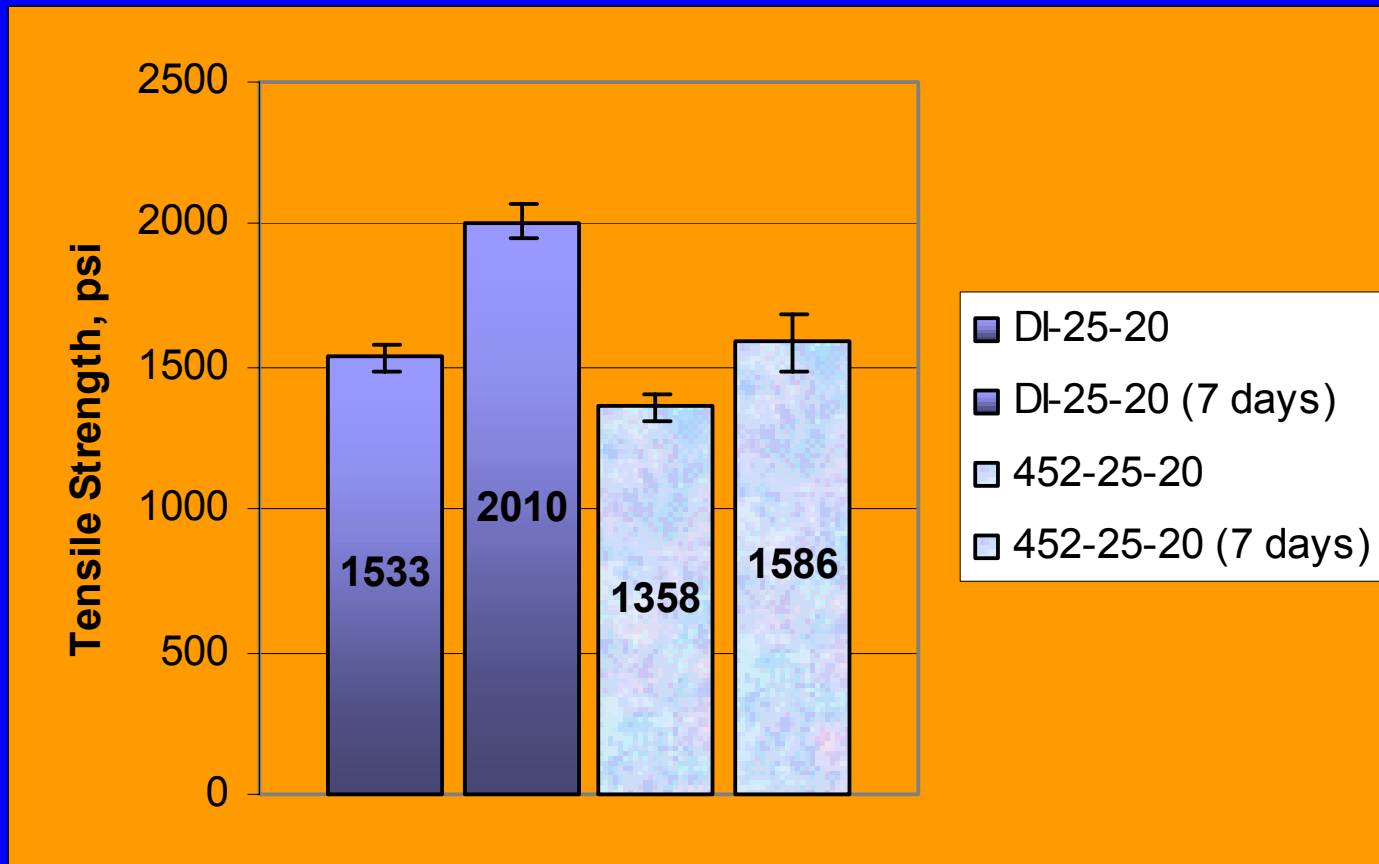
Gun	Nozzle A	Nozzle B	$\Delta P$	Vol. Ratio	Spray Pressure A	Spray Pressure B
DI-28-28	0.028	0.028	0	1.01	2300	2300
DI-25-20	0.025	0.020	100	1.01	2400	2300
453-25-23	0.025	0.023	200	1.00	2200	2400
DI-23-23	0.023	0.023	300	1.01	2100	2400
DI-32-20	0.032	0.020	1100	1.02	1700	2800

# Nozzle Diameter



Effect of nozzle diameter with direct impingement on tensile strength at 24 hrs.

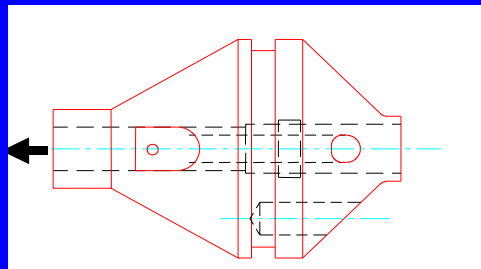
# Nozzle Orientation



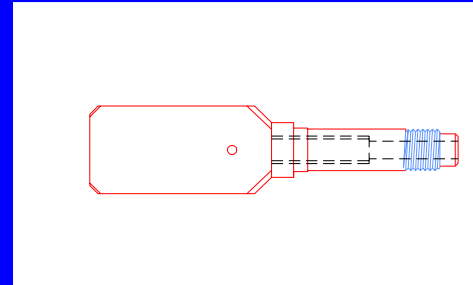
**Effect of nozzle orientation on tensile strength at 24 hours and 7 days.**

# Mixing Chamber Geometry

DI-28-28

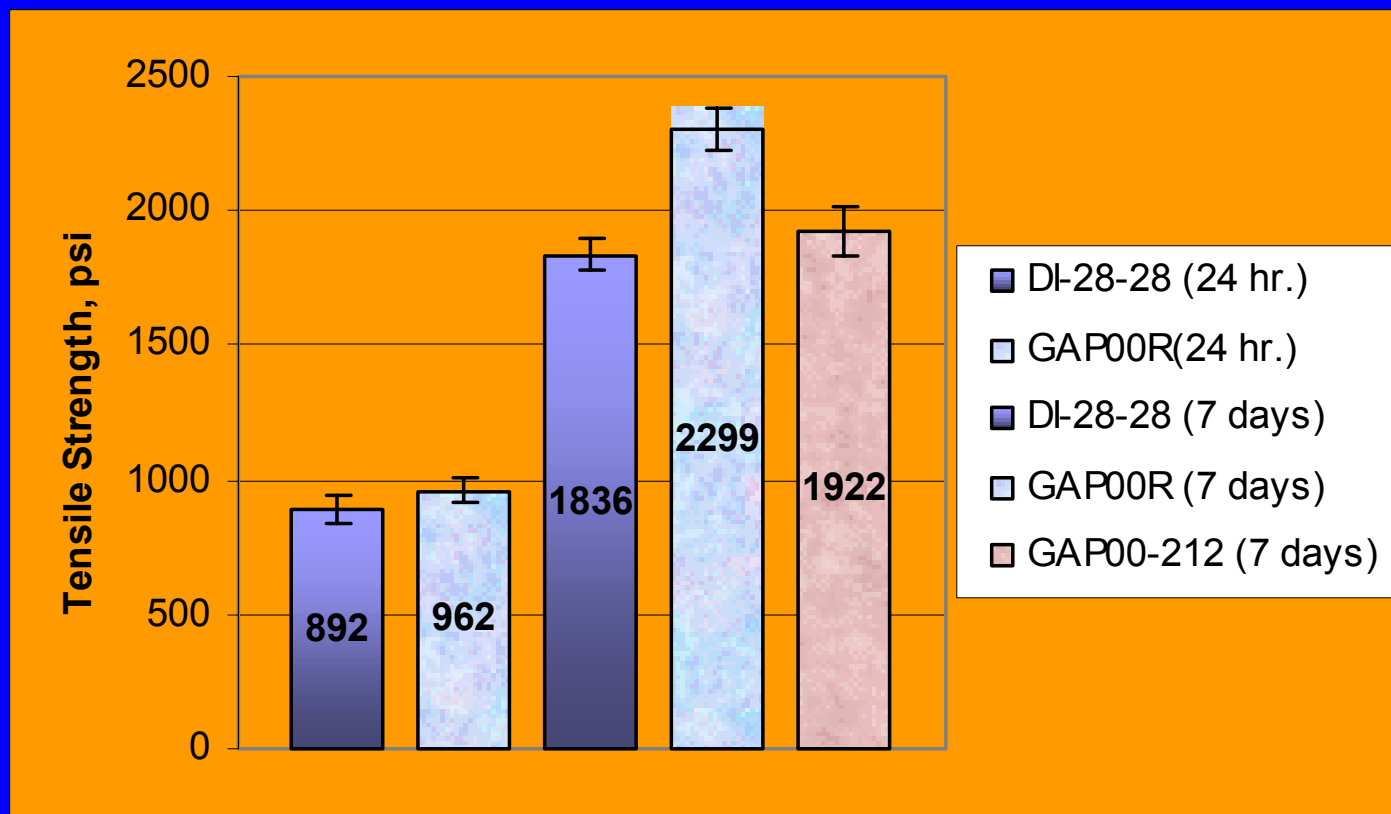


GAP00R



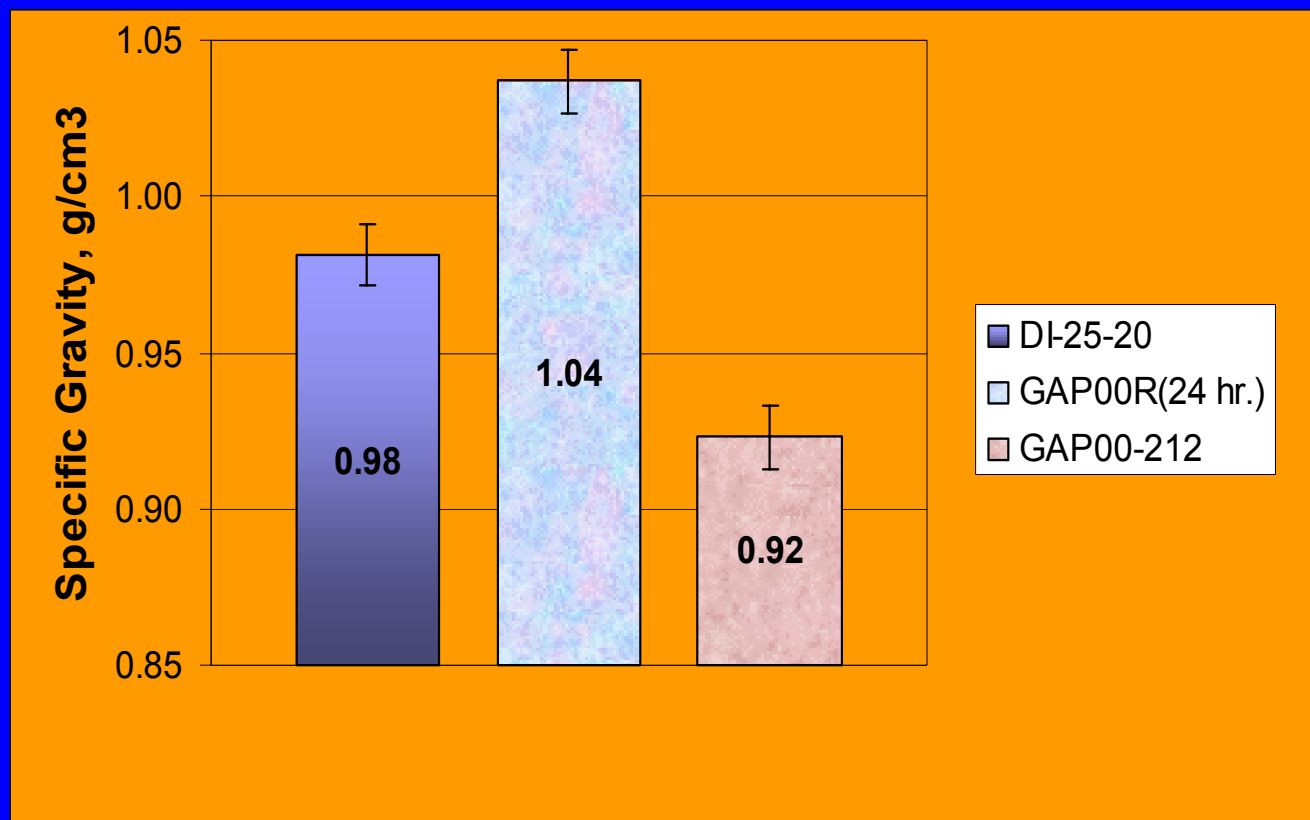
	Gallons per minute, GPM	Mixing Chamber Volume (mm <sup>3</sup> )	Mixing Chamber Diameter, (mm)	Residence Time, ms	Turbulent Mixing Volume (mm <sup>3</sup> )
DI-28-28	0.82	86.4	3.17	1.79	50.2
GAP00R	1.10	47.8	1.18	0.74	2.6

# Mixing Chamber Geometry



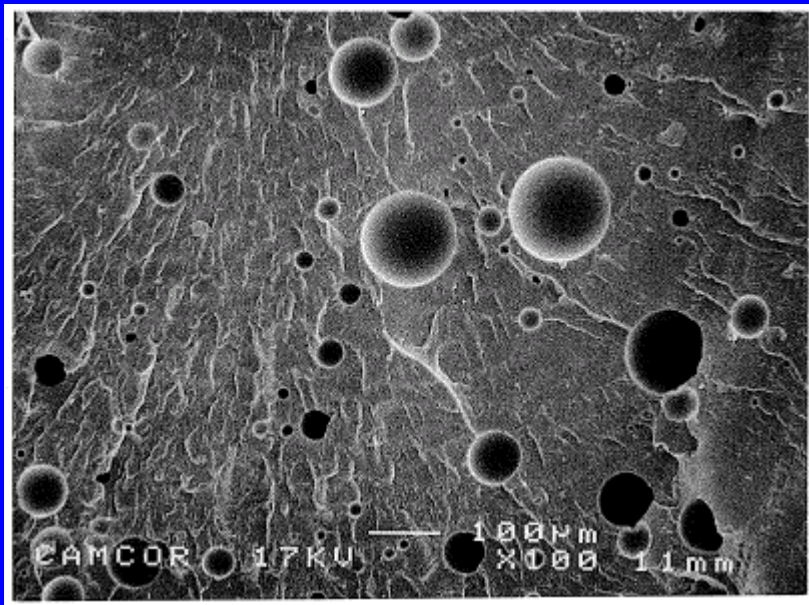
Effect of mixing chamber dimensions on tensile strength (24 hrs. & 7 days).

# Mixing Chamber Geometry

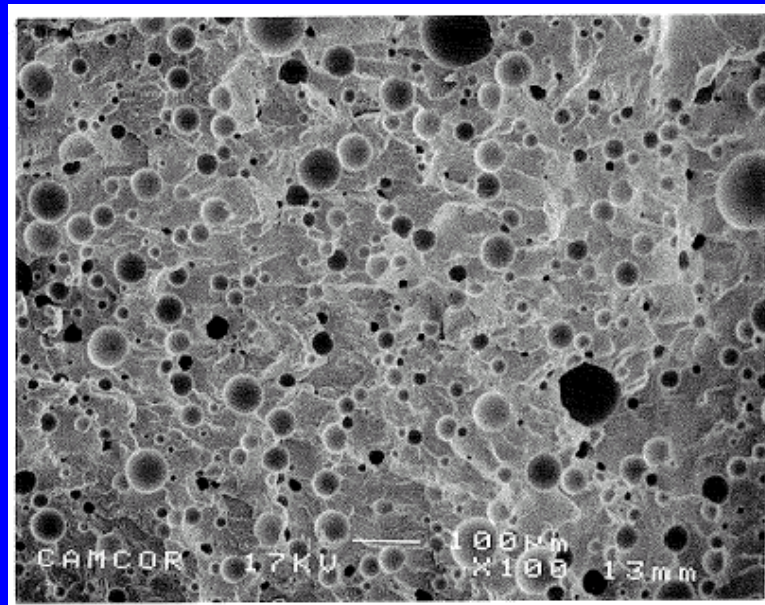


Effect of spray tip assembly on specific gravity.

# Mixing Chamber Geometry



GAP00R



GAP00-212

# Conclusion

- Mixing process includes, macromixing, micromixing, turbulence, and diffusion.
- Mixing efficiency determines how quickly the ultimate physical properties will be reached.
- Higher the processing pressure, the better the mixing efficiency. (*reaction viscosity*)
- Proportioner will process “On-Ratio”, even with a large pressure differentials between components.
- Manufacturer is responsible for defining process parameters to produce specified properties.

# Acknowledgements

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- John Courier, *Equipment & Coating Technologies*
- Dudley Primeaux II, *Primeaux Associates*

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