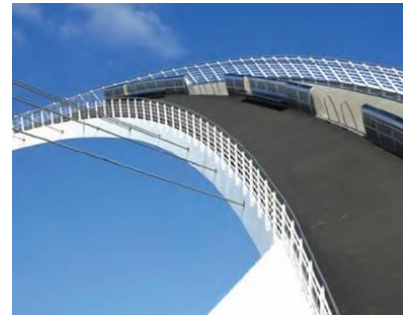


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# Construction

Cement Grinding Aids



# I. Effect: Improve grinding efficiency

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Improve grinding efficiency	Chemistries
POLYOL	
Glycerol	Glycerol
DEG	Diethylene Glycol
AMINE ALKOXYLATES (HUNTSMAN PRODUCT)	
Amine® C6	Morpholine bottom
Amine® C8	Morpholine bottom
DEHSCOFIX® GA-850	Blend of products
DEHSCOFIX® GA-900	MDEA bottoms
SURFONIC® EDA 4/80	THEED (Tetrahydroxyethyl ethylenediamine)

## II. Effect: Enhance strength development

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Chemistries	Secondary effect in concrete with the use of amine in cement grinding aids
HUNTSMAN PRODUCTS	
MDEA (Methyl diethanolamine)	Excellent early concrete strength development
TEA (Triethanolamine) AMINE GA (TEA Bottom)	Early concrete strength development
THEED (Tetrahydroxyethyl ethylenediamine)	Enhance early and final compressive strength Improve grinding efficiency

# Typical amine content of various CGA

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Product range	Chemical descriptions	Sources	Typical amine content, mol/g		
			Primary	Secondary	Tertiary
MDEA	Methyl diethanolamine	Europe, Laffans India, US, APAC	1.0	1.0	8.3
TEA	Triethanolamine	APAC, Laffans India, Europe, US	1.0	1.0	6.7
Amine GA	TEA bottom, sometime called polytriethanolamine	US, Laffans India	1.0	2.0	6.4
SURFONIC® EDA 4/80	Tetrahydroxy ethyl ethylene diamine	US	1.0	4.2	4.3
DEHSCOFIX® GA-900	MDEA bottom	US, Laffans India	1.0	1.4	5.1
Amine C8	Morpholine bottom	Europe	0.3	2.8	4.2
Amine C6		US	-	-	-

# Performance Data in Cement

Various blend compositions

- **Cement type I:**

- Density = 3.24 g/cm<sup>3</sup>
- Blaine Fineness = 3818 cm<sup>2</sup>/g (ASTM C204-96a)
- Specific surface area (Wagner)= 2183 cm<sup>2</sup>/g (ASTM C115-96a)
- Sieve residue (45 μm residue) = 0.79% (ASTM C430-96)

- **Chemical composition**

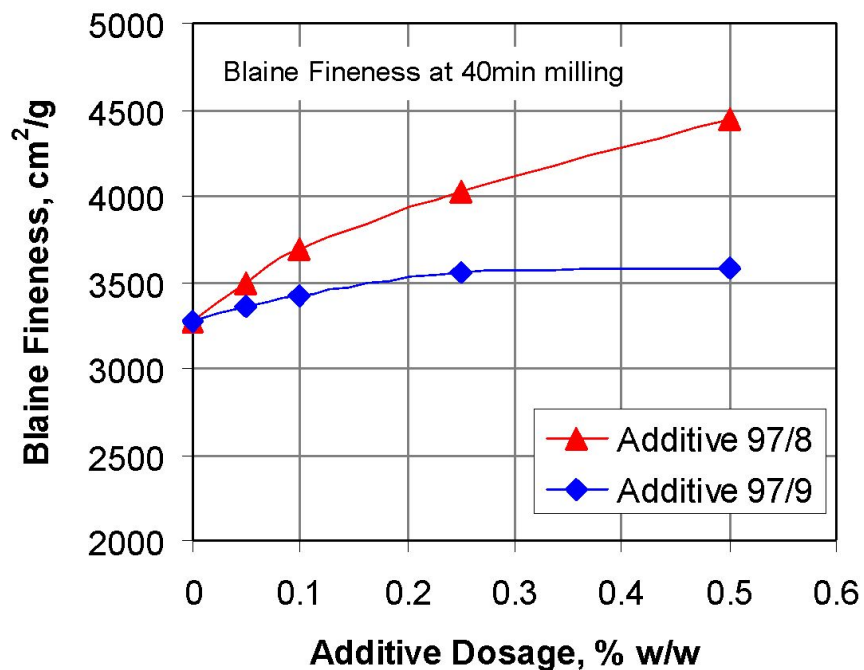
	CaO	SiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	SO <sub>3</sub>	K <sub>2</sub> O	TiO <sub>2</sub>	P <sub>2</sub> O <sub>5</sub>	Na <sub>2</sub> O	MgO
Mass fraction, %	64.0	20.7	4.7	3.2	2.4	0.70	0.30	0.12	0.07	2.2

Loss on Ignition (LOI) = 1.67

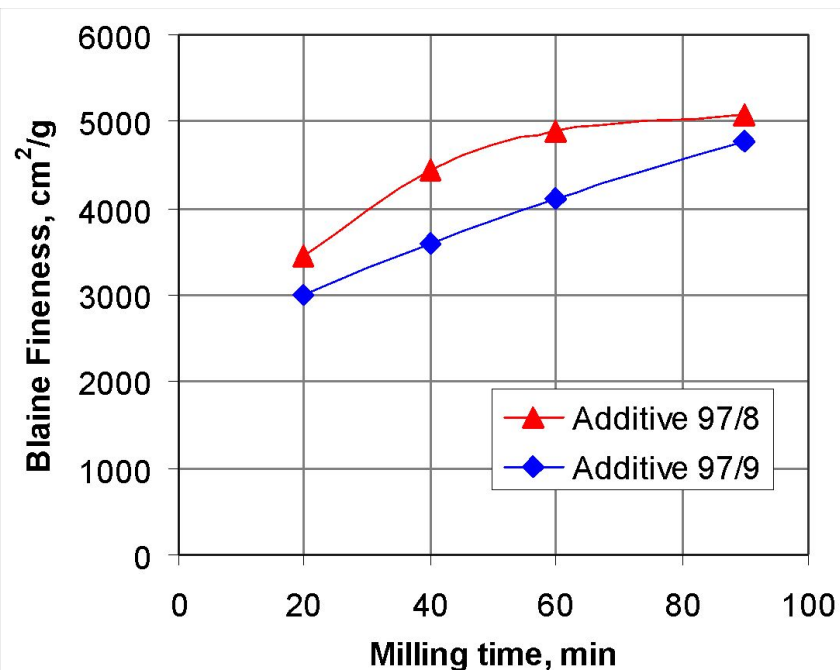
- **Cement compounds**

	C <sub>3</sub> S	C <sub>2</sub> S	C <sub>3</sub> A	C <sub>4</sub> AF
Mass fraction, %	60	14	7	10

### Fineness vs CGA dosage



### Fineness vs Milling time



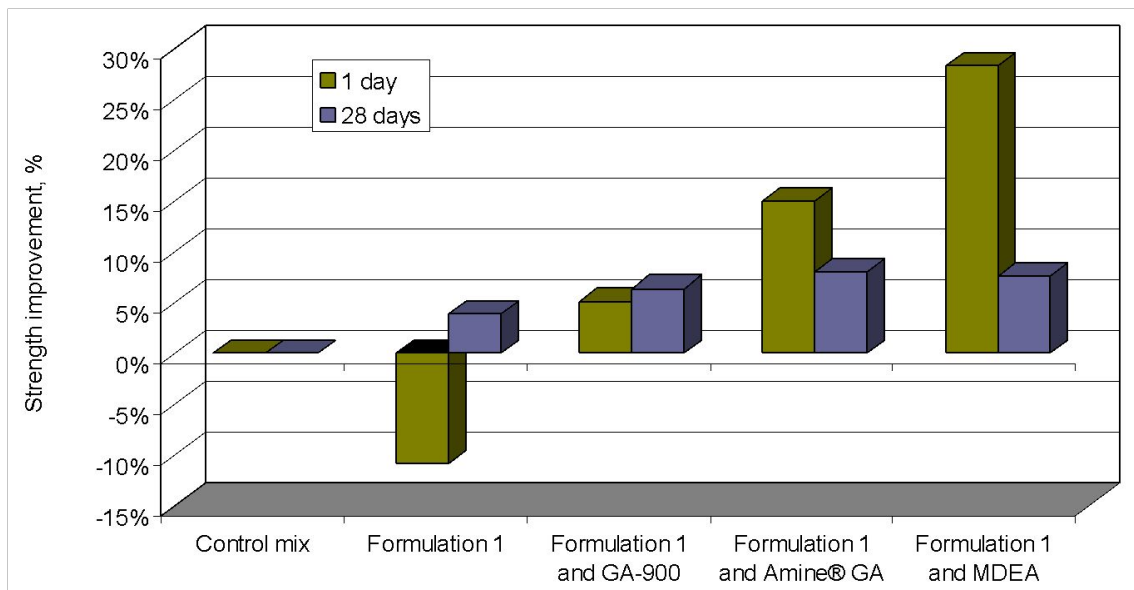
**Note:** Additive 97/8 and 97/9 are blend of glycol and TEA at various ratio

Similar formulation to TERIC® 421

# Formulation containing Amine C8



Components	Control mix	Experimental			
		Formula 1	+ GA-900	+ Amine GA	+ MDEA
Amine C8	-	50	18.5	18.5	18.5
Glycerol by product	-	50	18.5	18.5	18.5
GA-900	-	-	37.5	-	-
Amine® GA	-	-	-	37.5	-
MDEA	-	-	-	-	37.5
water	-	-	25.0	25.0	25.0





# DEHSCOFIX® GA-900 Formulations

	Control mix	Formulation 1	Experimental				
			2	3	4	5	
<b>Components</b>							
DEG	-	-	-	36.9	28	28	
Amine GA	-	-	-	-	10	20	
DEHSCOFIX® GA-900	-	-	36.9	36.9	35	25	
Amine C8		50	18.5				
Glycerol by product	-	50	18.5	-	-	-	
Acetic acid	-	-	1.3	1.3	1.5	1.5	
Water	-	-	24.9	24.9	25.5	25.5	
<b>Blaine Fineness, cm<sup>2</sup>/g</b>							
T20	2718.0	2754	2928	2940	2962	2995	
T40	3268.9	3339	3568	3568	3614	3659	
T60	3637.1	3970	4133	4109	4157	4212	
<b>Fresh and Hardened Properties in Concrete</b>							
Slump, mm	-	180	170	160	170	165	
Strength, MPa	1 day	-	2.30	2.60	2.45	2.65	2.68
	7 days	-	15.33	18.50	17.50	18.00	18.5
	28 days	-	25.00	28.80	26.50	28.00	29.00

- Initial compressive strength of THEED is higher than TIPA.
- Higher slump than the blank (without cement grinding aids) could indicate better grinding efficiency.

