TOC® - Thixotropic Oilwell Cement

1. System Description and Benefits

TOC cement slurry is composed of cement and a special additive which provides thixotropic rheological behaviors while the pumping rate changes. TOC quickly forms a gel structure while we slow down the pumping rate or completely stop pumping, and the gel structure disappears if pumping resumes. The thixotropic and expansive properties of TOC systems not only provide better zonal isolation of oilwell cementing but also minimize the loss of cement into formation.

Characteristics	Benefits
Simple slurry composition	Easy field mixing
Thixotropic rheological behavior	Superior fluid loss control and zonal isolation performance
Controllable gel breaking	
Expansive properties	
Not sensitive to cement and mix water	Applicable to various oil and gas well cementing
Adjustable thickening time	

2. TOC Additives

Product	Code	Form
Antifoaming Agent	KCM003	Colorless liquid
Dispersant	KCM012S	Brownish powder
TOC Additive	KCM038	Light green liquid
TOC Fluid Loss Control Agent	KCM039	White powder
TOC Retarder	KCM067	White to yellow powder to brown powder

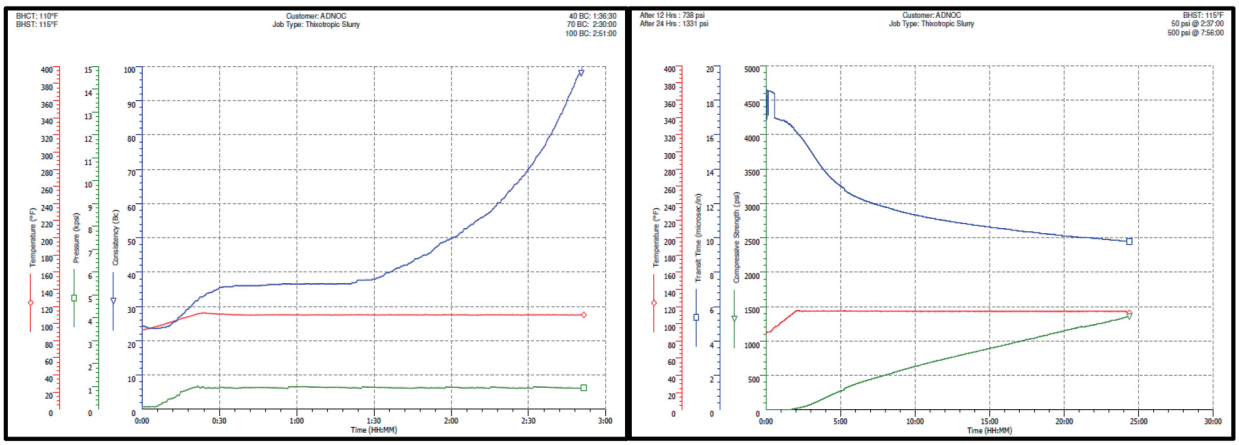
3. Typical Properties and Field Applications

TOC technology was commercialized in 2016 successfully and has been applied in various oil and gas fields in the world. It has been proved to be effective in cementing oil or gas wells with the following conditions and properties:

Temperature: BHST 104-212°F (40-100°C)
Density: 11.20 ppg to 14.50 ppg (1.35 – 1.75 g/cm^3)
Mix-water: Fresh water
Gel strength: YP: 30-100 lbs/100ft^2
Temperature: BHST 104-212°F (40-100°C)

Further information about field jobs is described in documented “Case History of TOC Technology”.
Typical thixotropic properties of TOC slurries are shown in the following Table and Figures.

R1-B1-S1	RPM	3	6	30	60	100	200	300	PV (cP)	YP (lbf/100ft^2)
80°F	Ramp Up	14	20	42	48	54	62	68	43	32
	Ramp Down	20	26	50	54	56	63	68		
110°F	Ramp Up	45	49	135	179	195	222	236	182	86
	Ramp Down	30	42	120	160	185	213	236		
10 sec gel strength (110°F)		33				10 min gel strength (110°F)			100	
1 min gel strength (110°F) (100 rpm shearing)		54								



4. Precautions and HSE Considerations

TOC additive (KCM038) plays the most important role in cementing jobs with TOC slurry. In addition, fluid loss agent (KCM039), retarder (KCM067) and expanding agent (KCM025LT, KCM025 and KCM025HC) are engineeringly developed for TOC system because KCM038 is not compatible with regular fluid loss control agents, dispersant and retarders.

The laboratory procedures, quality assurance program and guidelines for field mixing and handling of TOC systems are described in TOC fluid manual.

Refer to the technical sheet and SDS of the respective product for the health, safety and environmental information of each product.

Antifoam Agent KCM003

1. Introduction

Foams formed while mixing cement slurry cause many problems such as lower and wrong density reading, poor particle wetting and hydration efficiency, and pumping difficulties due to pump cavitation and loss of suction. KCM003 antifoam agent is often required in cement slurry to prevent foaming tendency and avoid problems described above.

2. Physical Properties and Hazards

Additives	Form	S.G.	Water Solubility	Melting/Flash Point (°C)	Health Hazard	Physical Hazard	pH
KCM003	Colorless liquid	0.98-1.03	Soluble	>93	Eyes Irritation	None	8-9

3. Chemical Properties and Application

KCM003 is an effective antifoam agent in most cement slurries that do not have high salt concentrations. It is NOT a foam breaker therefore KCM003 should be always added into mixing water before any foam forms. Higher agitation is required in cold weather for better dispersion.

4. Treatment

KCM003 is an effective antifoam agent in most cement slurries that do not have high salt concentrations. It is NOT a foam breaker therefore KCM003 should be always added into mixing water before any foam forms. Higher agitation is required in cold weather for better dispersion.

5. Packaging

KCM003 is supplied in 5 gallons high density polyethylene (HDPE) drums or 55 gallons steel drums. Keep it away from extreme conditions such as places near flames or direct sunlight.

Dispersant KCM012S

1. Introduction

Dispersants can improve mixability of cement slurry and reduce slurry viscosity. This will reduce pumping frictions and lower the critical rate for turbulence flow. Most dispersants achieve the above objectives by separating solid particles and suspending them homogeneously in cement slurry. Many dispersing agents in cement slurry are also able to help improve fluid loss properties of the slurry.

2. Physical Properties and Hazards

Additives	Form	S.G.	Water Solubility	Flash Point (°C)	Health Hazard	Physical Hazard	pH (1% solution)
KCM012S	Brownish powder	1.10-1.30	Soluble	ND	Eyes irritation	None	7.5-9.0

3. Chemical Properties and Application

As described above KCM012S provides cement slurry placement in turbulent flow easily and at minimal pumping pressure due to lower frictions, especially in applications of smaller tubulars and viscous slurry designs. The unique chemical nature of KCM012S will disperse solid particles effectively and stabilize them homogeneously in cement slurries to prevent any settling problems and reduce free water content.

4. Treatment

KCM012S is generally used at concentrations from 0.10 to 1.0%BWOC depending on the brands of cement and applications. Caution should be taken to “over-disperse” the slurry at higher KCM012S concentrations. Excess free water and particle settling will be observed if slurries are “over-dispersed”.

5. Packaging

KCM012S is supplied in plastic-lining bags with net weight of 25kg/sack. It should be stored in shaded areas with good ventilation. Keep it away from high temperature, humidity, and direct sunlight.

TOC Additive KCM038

1. Introduction

A liquid additive, KCM038, has been developed to extend the use of TOC systems to offshore platforms or any other location where the handling of solid additives is impractical. KCM038 imparts the thixotropic properties characteristic of TOC slurries.

KCM038 slurries do not expand upon setting and remain dimensionally stable. It can also be used with any Portland cement. Another advantage of using KCM038 is that higher early and ultimate compressive strengths result.

2. Physical Properties and Hazards

Additives	Form	S.G.	Water Solubility	Health Hazard	Physical Hazard	pH
KCM038	Light green liquid	1.20-1.30	Soluble	Eyes, Skin	Corrosive	1-2

3. Chemical Properties and Application

The defining property of TOC slurries is thixotropy. This is the property of becoming fluid when in motion, such as when being pumped and of forming a gel when allowed to stand. Thus, TOC slurries are thin when mixed and pumped, but after motion has been stopped, they rapidly form a gel structure. This gel structure is strong enough to support the hydrostatic pressure, preventing fallback. If sufficient force is applied to move the slurry, the gel structure is disturbed, and the slurry returns to liquid phase and pumpable state.

TOC systems develop gel strength according to the additive concentration. Reduced gel-formation time and increased gel strength can be achieved by adjusting the KCM038 concentration.

Laboratory tests show that KCM038 provides uniform gel strength and superior thixotropic properties when used with a wide variety of cement brands.

4. Treatment

The thixotropic system consists of KCM038, KCM039 and KCM040.The slurries are designed for use in temperature range from 40 to100°C BHCT.

When the slurry density is between 1.5-1.9sg, 0.2-1.5gps is considered optimum concentration in most fluid designs.

5. Packaging

KCM038 is supplied in 5 gallons High density polyethylene (HDPE) drum or can. Keep it away from extreme conditions such as places near flames or direct sunlight.

TOC Fluid Loss Control Agent KCM039

1. Introduction

The thixotropic system is a very good solution for loss circulation, and KCM039 can be compatible with most of the thixotropic agents. As a FLA, KCM039 is very important for cementing job design, especially for the TOC design. Most fluid loss control agents affect other properties of cement slurry such as rheology, retardation, and cement set strength. Comprehensive laboratory testing is generally required for selection of fluid loss control agents.

2. Physical Properties and Hazards

Additives	Form	S.G.	Water Solubility	Melting/Flash Point (°C)	Health Hazard	Physical Hazard	pH
KCM039	White powder	1.37-1.57	soluble	None	None	Dust	None

3. Chemical Properties and Application

KCM039 is a solid fluid loss control agent that can be used for TOC slurry design at wide temperature (50-200℃) and density ranges (1.10-2.70sg) due to its unique chemical natures. It can be mixed with freshwater, seawater, and saltwater depending on application requirement.
It is approved by testing that KCM039 is not sensitive to cement brands especially for low to medium density slurry designs. However, like most polymeric fluid loss control agents, KCM039 generally increases slurry viscosity slightly especially at higher loading.

4. Treatment

0.2-2.0%BWOC loading is generally required for effective fluid loss control depending on temperature, mixing water, and slurry density.

5. Packaging

Each sack of KCM039 contains 25kgs with +/- 0.25kgs. Sacks consist of three layers with one polyethylene inner layer and two paper layers.

Retarder KCM067

1. Introduction

KCM067 is a modified sodium lignosulfonate-based product used primarily as a cement retarder in oil well cementing applications. Of the chemical compounds that have been identified as retarders, lignosulfonates are the most widely used.

2. Physical Properties and Hazards

Additive	Form	Density	Lignosulphonate Contents	Physical Hazard	pH (1% Solution)
KCM067	Brown Powder	1.30-1.50	⩾68%	Moderate - Dust	6

3. Chemical Properties and Application

Lignosulfonate is a metallic sulfonate salt derived from the lignin recovered from processing wood waste. Retarder is a type of additive that can slow down cement hydration reactions. It is useful to allow cement slurry to be pumped in a longer time.

Lignosulfonates are compatible with anionic and non-ionic materials, dispersants, wetting agents and most organic and inorganic materials.

4. Treatment

KCM067 is typically used at a BHCT of 212°F or lower and at a concentration of 0.5% BWOC or less. It may be used at higher temperatures but will normally be limited by economic considerations.

5. Packaging

KCM067 is supplied in plastic-lining bags with net weight of 25kg/sack. Under dry conditions, powder products remain stable for several years.