

PolarSet® - Non-Corrosive Anti-Freeze Chemical Admixture for Cold Weather Concrete

What is the Innovation: This innovation consists of a novel chemical admixture formulation, marketed under the name, Polarset, which allows the production of concrete under sub-freezing conditions. An especially unique capability of this patented product is that when used at the dosages to impart sufficient setting and strength development of freshly mixed concrete exposed to temperatures as low as 20 F (-7 C), there is no tendency of the chemical admixture to increase the corrosion potential of the concrete as would be expected when large salt-based additives are used as anti-freeze agents. In fact, this innovative chemical admixture actually reduces the probability of corrosion to steel re-enforcement, even when the concrete is exposed to externally applied chloride-based deicing salts.

Why is the product innovative: The innovative setting, strength, and anti-corrosive properties of Polarset is based on the unique combination of several patented technologies:

- a. A synergistic set accelerating performance obtained from mixtures of calcium salts such calcium nitrate and calcium nitrite with glycols (US 5,348,583 and 5,340,385).
- b. The blending of two calcium salts - calcium nitrate for set acceleration, and calcium nitrite for set and strength acceleration, and corrosion protection.

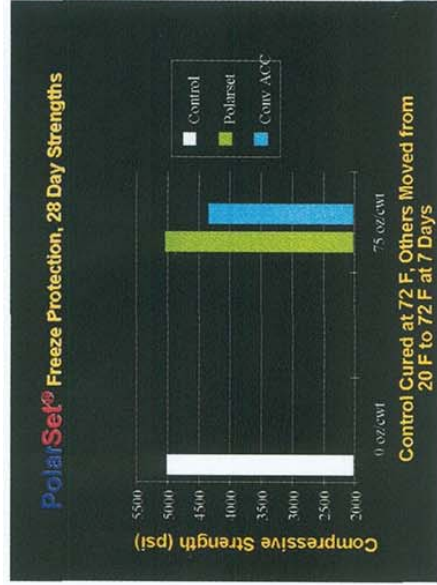
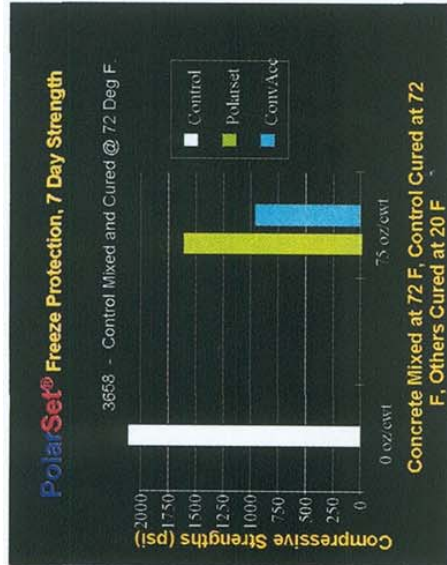
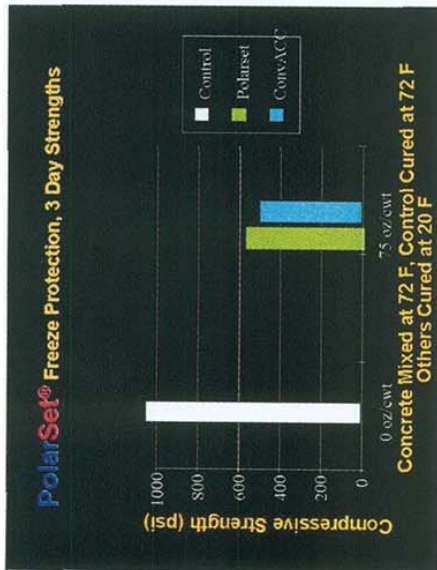
These benefits result from the admixture's ability to accelerate the hydration reactions associated with Portland cement, which in turn, shorten the time of setting and increase the rate of strength gain of the treated concrete.

What the innovative product changed or replaced: Polarset provides the opportunity for decreasing construction costs, especially in cold weather by reducing the requirements for protection and curing, and shortening the time for the reuse of formwork. Prior to the availability of this technology, there was no way to produce and place durable concrete where the concrete reached sub-freezing temperatures while still in the plastic state, AND yet was not susceptible to the corrosion of steel re-enforcement, especially when treated with externally applied chloride deicing salts PolarSet now enables the use of concrete under such harsh environment with significantly reduced concern for short and long term durability.

here and when did the innovative product originate, has been used, and is expected to be used in the future: Polarset originated in the Research Laboratories of W.R. Grace, and resulted from the collaboration of a multifunction team of material scientists, concrete technologists, and chemists. This innovative chemical admixture, which has been certified to meet the ASTM C 494 standard for set accelerating admixture (Type C), has been used as an effective set and strength accelerator for concrete produced and placed above freezing temperatures extensively throughout the United States and Europe since the mid-nineties. Use under sub-freezing conditions has been well documented in several studies (1,2) but commercially limited due to lack of relevant ASTM standards. Use of Polarset is expected to increase rapidly as the ASTM C09.23 sub-committee on Chemical Admixtures is now in the process of developing a new Cold Weather Admixture standard.

- (1) A.A. Jeknavorian, N.S. Berke and D.F. Shen, "Performance Evaluation of set Accelerators for Concrete," Fifth CANMET/ACI Conference on Superplasticizers and Other Chemical Admixtures in Concrete, SP-173-4, 1997.
- (2) C.J. Korhonen, E.R. Cortez, T. Durning, and A.A. Jeknavorian, "Antifreeze Admixtures for Concrete," CRREL, Special Report, 97-26, October 1997.

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The plots above illustrate how concrete mixtures admixed with Polarsset, still gain compressive strength, though exposed and cured at 20 F ambient temperature for seven (7) days starting immediately after the mixing process. After seven days of curing at 20 F, the concrete was then placed at ambient conditions (72 F). The strength at 28-days was comparable to the reference concrete which had been cured at ambient conditions throughout the 28-days. An older set accelerator technology as represented by a Conventional Set Accelerator (Conv ACC) provided inferior set and strength performance.

Potentiostatic polarization tests were conducted to understand the possible corrosion effect of Polarsset versus Conv ACC. A voltage was applied to steel rebar embedded in mortar mixtures prepared with: (a) no added chlorides, and (b) 5 pcy NaCl. The current density data below indicates: (a) in the case of the mortars w/o NaCl, no increased current with Polarsset versus a reference mortar mixture, while Conv ACC caused a 15 x increased current density; and (b) in the presence of NaCl, Polarsset dramatically reduced the current density versus the control mixture and the mortar dosed with ConvACC.

POTENTIOSTATIC POLARIZATION TEST

RESULTS	ADMIXTURE DOSAGE RATE	AVERAGE CURRENT DENSITY
A. NO NaCl	ml/100 kg	uA/cm ²
CONTROL	980	0.54
POLARSET	5220	0.56
Conventional ACC	7620	0.36
	980	0.57
	5220	0.56
	80	6.58

POTENTIOSTATIC POLARIZATION TEST RESULTS

A. WITH 3 KG/M3 (5 LBS/VD 3) NaCl	ADMIXTURE DOSAGE RATE	AVERAGE CURRENT DENSITY
ml/100 kg	OZ/CWT	uA/cm ²
CONTROL	-	264
POLARSET	15	2
Conventional ACC	80	3
	15	71
	80	552