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SURFACE AREA and ZETA POTENTIAL and their RELATION to SLURRY MIXES

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Much of what I say today may be repetitious; but, nevertheless, I still believe it important to this phase of road paving which is plagued more than other types by the inability to design by engineering principles.

To me, who has always been concerned with the emulsion involved, the lack of interest as regards the slurry aggregate has been a point of contention. Aggregate comprises three-fourths of a typical slurry mixture, yet for years its contribution to the mixing characteristics of slurry seal has been minimized. When SS-1 anionic emulsion is considered, the problem of aggregates is usually ignored; with the advent of cationics, and especially "Quick Sets" this is no longer possible.

In the past, I have discussed aggregates in detail; however, most problems occur because of the fines in a slurry mix. As aggregate particle size decreases, the surface area per unit weight increases exponentially. The portion of particular concern is that passing the #200 sieve (74 microns). Cationic emulsions are of particular interest; my remarks will be directed at them in relation to the fines. Since electrochemical depositions takes place on the aggregate surface, any increase in surface area will rapidly exhaust the available emulsion onto the surface. This can cause a premature or early break.

At ArmaK, we have been trying to correlate surface area to-the emulsion, since the moisture-emulsion proportion increases rapidly in direct relation to the surface area of the -200 fines. A surface area in the -200 fines exceeding 10 m²/gm is usually indicative of plastic fines with high moisture absorption - which also effects cohesion development.

The automatic surface area analyzer (a research tool) which we use determines surface area by a measurement of the amount of nitrogen gas that is absorbed onto the surface of the aggregate at minus 196 C. This is a monomolecular layer, and knowing the number of molecules covering the surface, the surface area is readily determined and displayed as m²/gm covered.

Experience at ArmaK has shown that, if the surface area exceeds 1.5 m²/gm and using a 1% E-11 emulsion as the control, the mix will be less than two minutes. It will then be necessary to modify the mix in some manner to obtain an acceptable mix life. Instead of pursuing that, (which could be the subject of another paper), we would like to list some slurry aggregates which have become part of our file.

	m ² /gm
Type III Warner slog (N.Y.)	3.0
Type II Warner slag	3.08
Blast furnace slag (N.J.)	0.53
Boiler slag (N.J.)	0.47
GNEISS screenings	0.81
1/4" block mix - limestone (IL)	1.1
Weatherford limestone (Texas)	2.2

Con Rock! (California) Siliceous	0.97
San Diego, Siliceous	4.45
Logan (CA) Siliceous	1.29
Chat (Kansas) mine tailings	2.06
Joplin Chat	1.53
Wolfe Slurry (Wis.) siliceous	1.60
Geneva Slag (Utah)	0.25
Glacial silt (crushed Granite) Alaska	0.96
Peckam Materials limestone (N.Y.)	1.80
Gravel (Ohio)	2.5
Limestone screenings (Pa.)	1.4
Granite (N. Mexico)	1.31
Silica sand (Pa.)	0.89

To give you a focal point, or some means of comparison, most disintegrated granite has a surface area of 3-6 m²/gm; blow sands, 10-20; clays and/or silt, 60-80.

We also have the gradation and mix design for most of the aforementioned aggregates. In all but one instance, those exceeding 2 m²/gm required some variation to be usable. This modification could be:

1. Fines Variation. Includes the addition of portland cement, hydrated lime or aluminum sulfate.
2. Chemical Variation. Either of the emulsifier or treatment of the pre-wet water.
3. Washing. Removal of deleterious fines, which are usually organic silt or clay.
4. Aggregate Substitution. If design testing reveals qualify slurry seal is not possible or economical with the aggregate.

At Armak, we view the total relationship of all the parts concerned in a slurry mix and use such information in selecting the emulsion (emulsifier system). This is done using "Zeta Potential" - which is the net electrical potential exhibited by colloidal particles - for our example, in an asphalt emulsion. We measure the movement of these asphalt particles with zeta meter. Each of our emulsifiers has been found to have a characteristic zeta potential dependent on the pH of the solution and the concentration of the emulsifier used. With this knowledge we can classify our emulsifiers, and thus be able to select a specific one at a given pH to create the emulsion system desirable for the type of aggregate involved in the slurry mix.

In brief, a particular emulsifier may be quite cationic at a pH of, for instance, 3 - but at pH 5.5 have half the cationic charge (expressed in millivolts). This might indicate- that at the higher pH on our slurry would have increased mix life.

Such information of course, we do not consider field applicable by a contractor; however, we and emulsion producers can make use of such knowledge in trying to develop that "blue sky" slurry - it mixes with any aggregate infinitely and sets within two minutes upon contact with the surface!