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EXPERIMENTS WITH SOLID PARTICLE SEEDING

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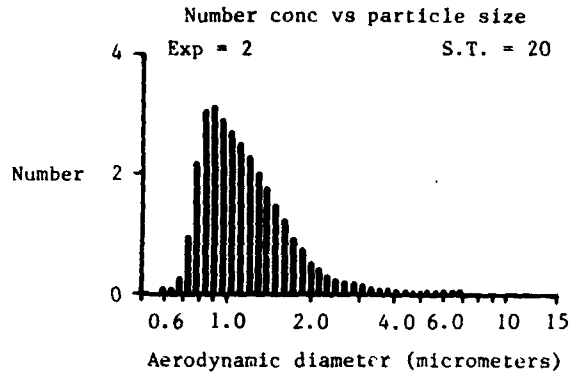
INTRODUCTION

This paper will discuss some of the laboratory experiments that are presently being conducted at Langley pertaining to solid particle seeding.

GRAVITY SEDIMENTATION OF KAOLIN FINEPARTICLES IN ETHANOL

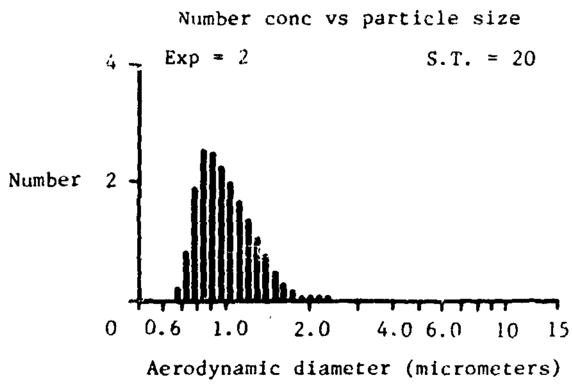
Kaolin, a hydrated aluminum silicate clay, is being investigated by LaRC as a seeding material for laser velocimetry. It is inexpensive but is polydisperse with some of the fineparticles being too large to follow wind tunnel flow and is in the form of non-spherical platelets having an aspect ratio of approximately 4/1. Gravity sedimentation experiments as a means of narrowing the fineparticle size distribution are being conducted. Figures 1(a), 1(b), and 1(c) show the fineparticle size distribution of Engelhard ASP 200 kaolin suspended in ethanol (0.00792 grams kaolin/ml etnanol) "as received," after 24 hours gravity sedimentation and after 48 hours sedimenation, respectively. A shearing atomizer (fig. 2) was used to inject the fineparticles. Gravity sedimentation was carried out in an 800 ml pyrex beaker (fig. 3). Following gravity sedimentation, the top 3.5 inches were siphoned from the liquid, which had a column height of 4.5 inches. In a like manner, longer settling times will serve to further narrow the fineparticle distribution range. As successive sedimentations are effected, the number of fineparticles per unit volume of ethanol decreases markedly. I have been able by means of a simple distillation to remove 90 volume percent of the ethanol which is then recycled for sedimentation of the next batch.

This work is still in progress; however, all indications are that gravity sedimentation can be successfully used to classify kaolin fineparticles for accurate laser velocimeter measurements.



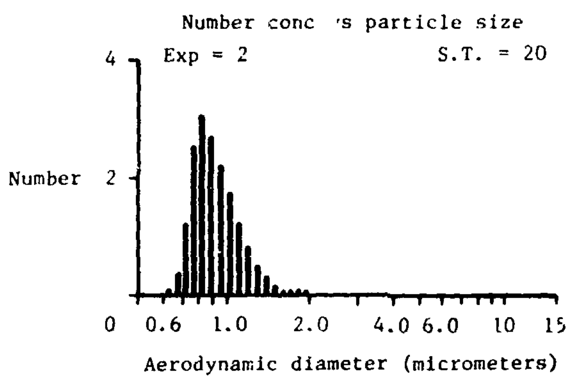
(a)

As received, 0.00792 grams ASP 200 Kaolin/ML Ethanol,
99% of particles ≤ 3.78μ, peak = 0.897μ



(b)

24 hour settling time, 99% of particles ≤ 1.98μ, peak = 0.835μ



(c)

48 hour settling time, 99% of particles ≤ 1.71μ, peak = 0.835μ

Figure 1

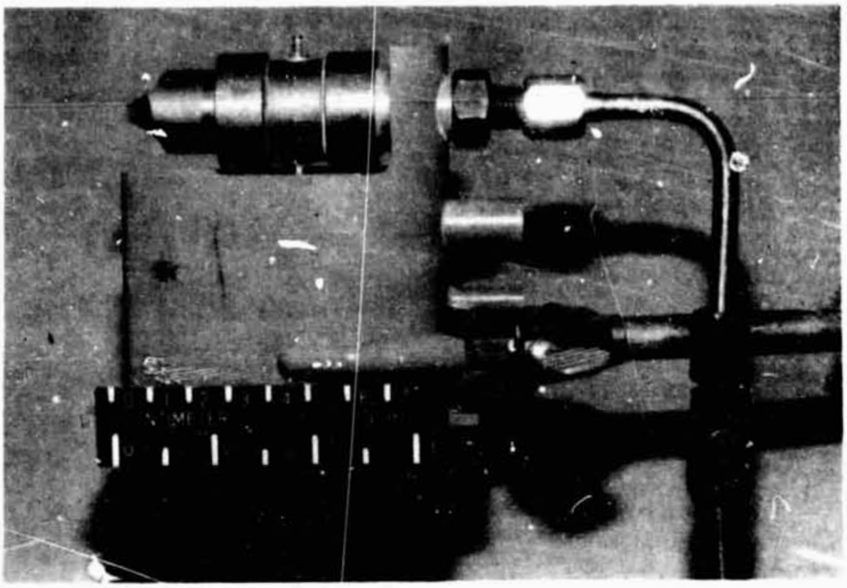


Figure 2

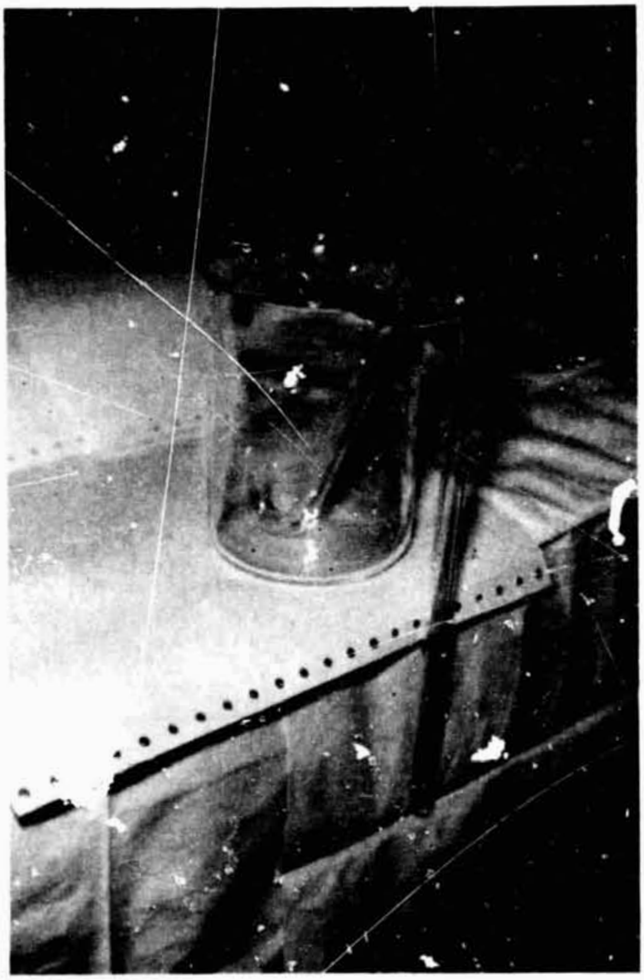


Figure 3

SEPARATION OF OVERSIZE FINEPARTICLES BY USE OF A CYCLONE SEPARATOR

Figure 4 shows the seeder used to inject the kaolin fineparticles, "as received". This seeder consists of a variable speed, rotating slotted wheel onto which the fineparticles are delivered from an air vibrated hopper. The fineparticles are aspirated from the wheel's surface into the airstream. Figure 5(a) shows the fine particle size distribution. Figure 5(b) shows the result of adding a small, "in-house fabricated" cyclone separator to the discharge of the above-mentioned seeder (fig. 6). Note however that 99 weight percent of the fineparticles still includes particles that are too large, being 3.05 micrometers in diameter. Since this is approaching the limit for size separation with a cyclone separator other means will be examined and this effort will be placed "on the back burner".

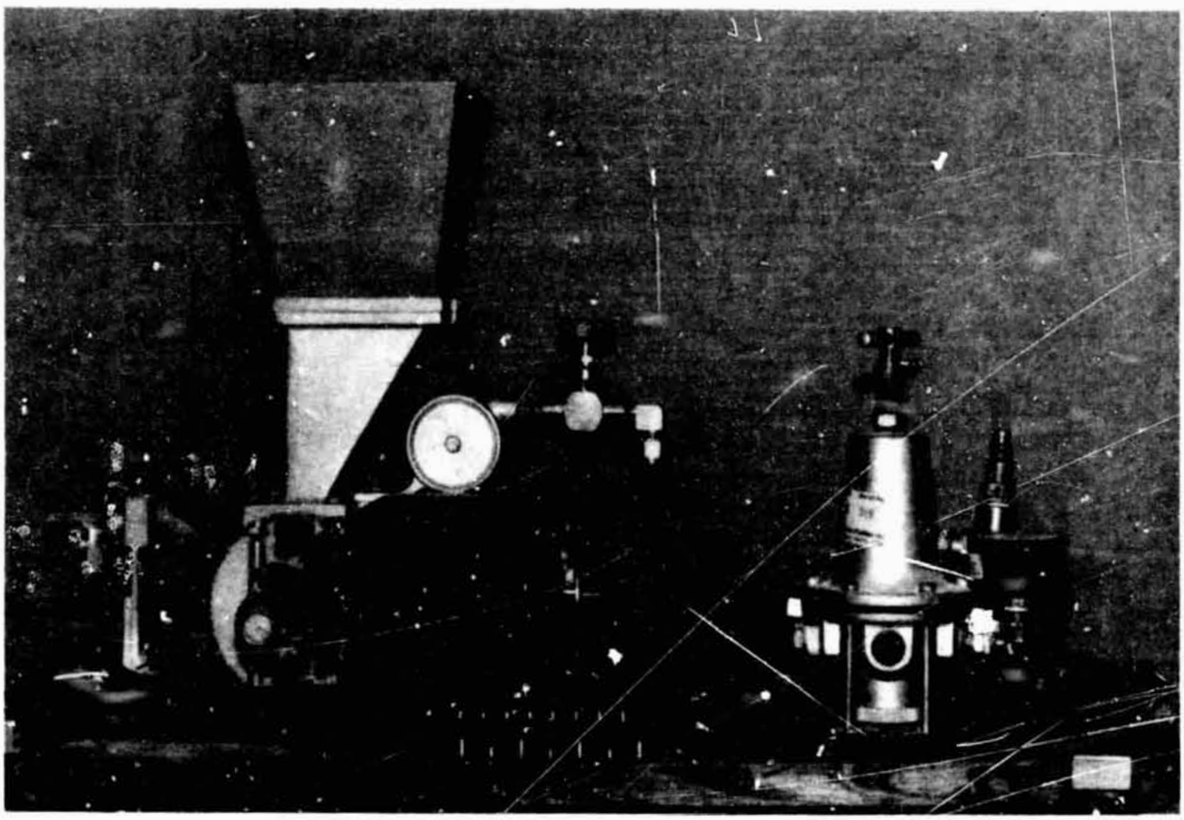
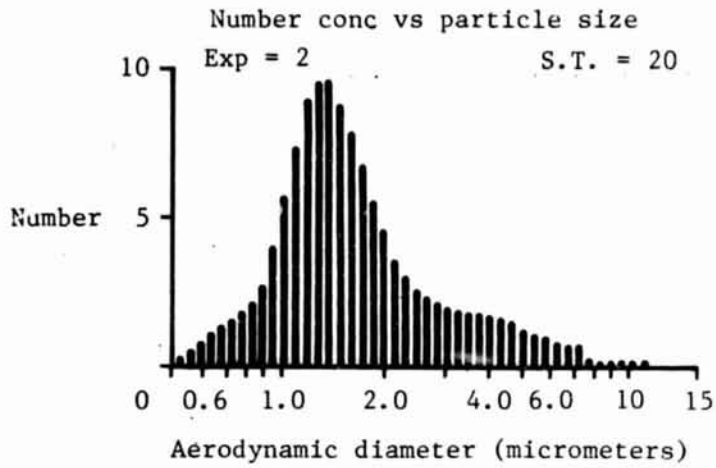
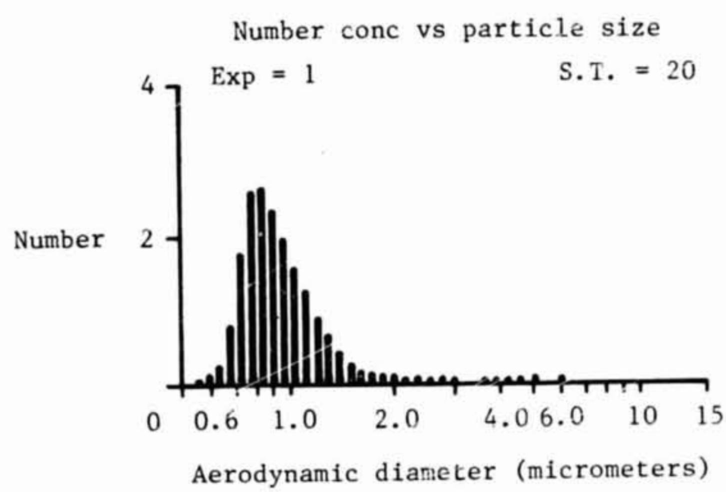


Figure 4



(a)

As received, injected with NBS seeder
99% of particles $\leq$ 6.73μ, peak, 138μ



Through cyclone separator, 99% of particles $\leq$ 3.05μ,
peak = 0.897μ

Figure 5

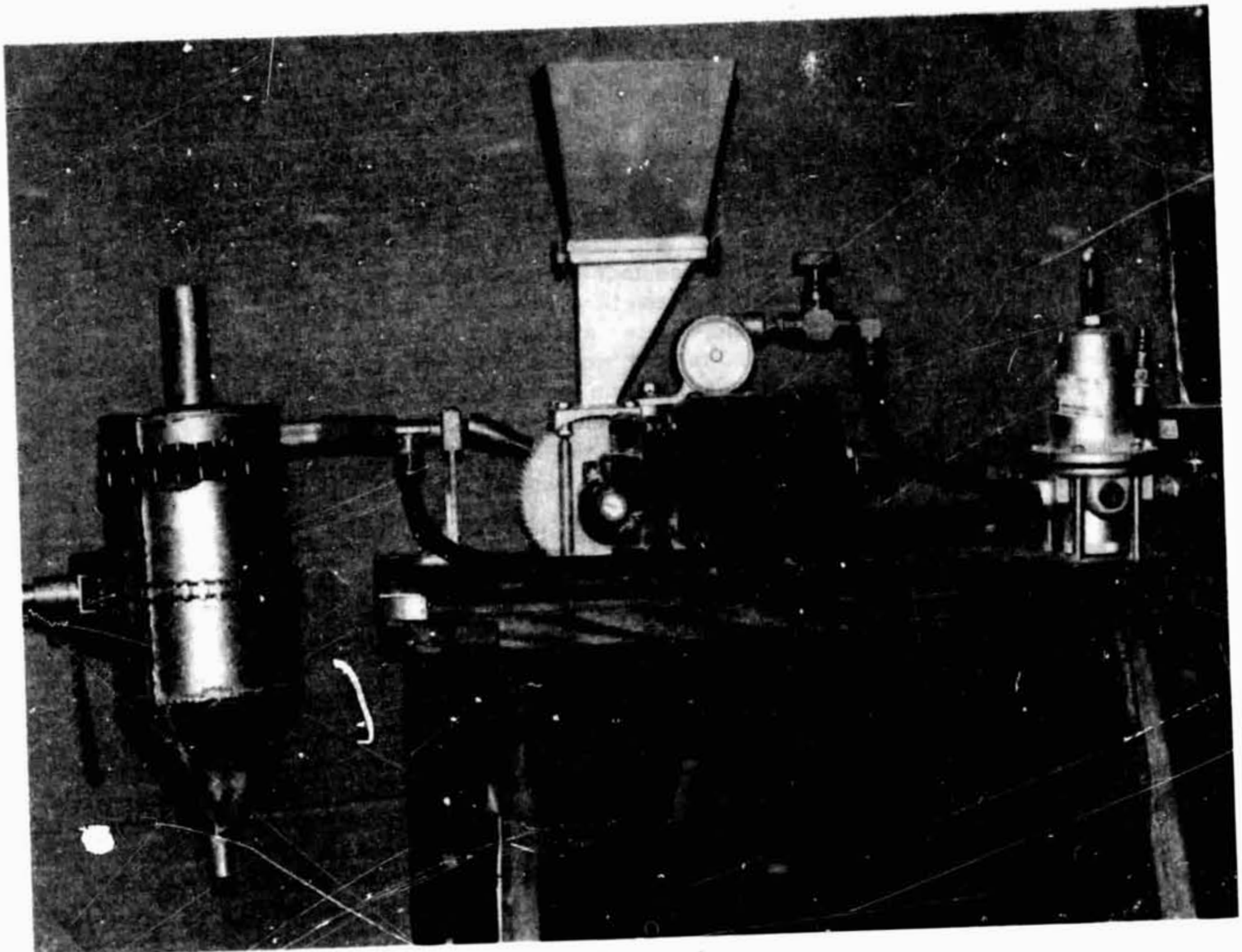


Figure 6

CONCLUDING REMARKS

You will notice that the data presented above is characterized in terms of "99 percent of the fineparticle size equal to or less than "a certain size. Actually this is not deemed to be good enough separation - the goal is size distribution such that "100 percent of the fineparticles are equal to or less than" the desired size. Work is ongoing in an effort to get cleaner, more precise cut-off points of fineparticle size with kaolin. Prime consideration is being given to the elimination of liquid convection currents during gravity sedimentation as a means to this end.

We are also investigating in-house manufacture of monodisperse Polystyrene latex (PSL) fineparticles in 1 micrometer diameter. PSL is commercially available (suspended in water) in an assortment of micrometer and submicrometer diameters but with the exception of 0.55 micrometer size is very expensive which can make its use prohitive in large wind tunnels unless the higher cost can be offset by a higher data rate resulting in shorter run times. Several laboratory batches of PSL have been made and although not perfect each batch is a little better than the last. If successful, PSL will result in a viable low cost option to kaolin as a liquid-suspended solid seeding material.