The Necessity for Developing Adequate Pilot Plant Facilities for the Advancement of Beet Sugar Technology

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In this presentation we are not presuming- to present any new data. It is well, however, to take stock periodically and see where we are and what is holding us back. From this it is quite often possible to learn what changes in course will result in more rapid advancement.

In looking at the present beet sugar technology and comparing it with thirty and forty years ago, two very different reactions can be obtained depending on the viewpoint from which the observation is made.

Take the rose colored viewpoint first and, may I add, in many ways a highly justified viewpoint.

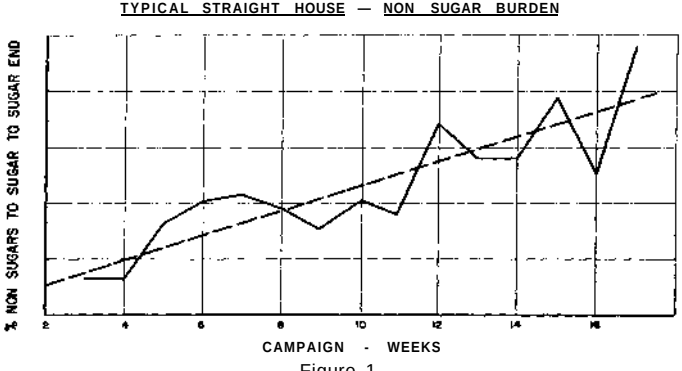

Figure 1.

The present day design of a new factory is a thing of beauty to behold in comparison with those factories built thirty and forty years ago. The performance today with its smooth flow of products through process with close control of additions, purity, etc., and the uniform high quality of sugar produced is a striking contrast with the lurching performance coupled with widely fluctuating house conditions of everything from battery supply temperature to raw pan purity and sugar quality which used to be the rule rather than the exception. There have been real advancements in the unit process equipment used in beet processing and in the instrumentation for control of these unit processes.

Looking at the advancement of beet sugar technology from this viewpoint, the people who have been instrumental in these developments can take pride in their handiwork.

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Now, looking at beet technology from another angle, we get a somewhat different picture.

Beet processing has for many years been a tremendous tonnage operation on a world scale. It might reasonably be expected that the composition and properties of the sugar beet, which is the basis of this industry, would be thoroughly understood. On the contrary, until the last two or three years no reliable and comprehensive beet composition data has been available. The answer hinged on the development of analytical techniques for this particular problem. The answer is just now beginning to unfold through efforts such as the work of the U.S.D.A. Western Regional Laboratory under the direction of Doctors McClay and Owens. Think of how many years of effort

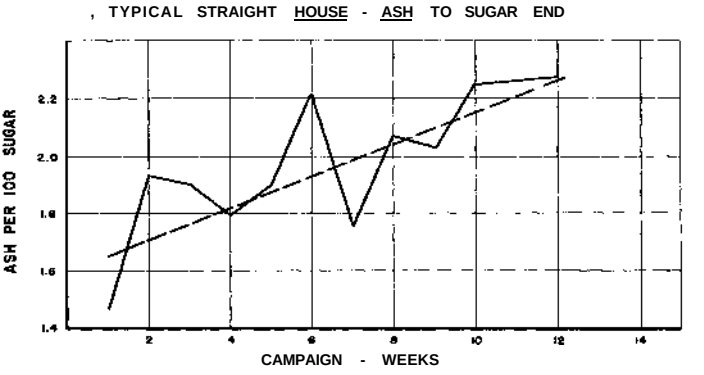

Figure 2.

have been spent by so many men groping for the behavior of beet juices and beet products without real knowledge of the reactants they were dealing with.

These results from the Western Regional Laboratory are among the finest examples of what may be expected from the application of adequate laboratory and pilot plant facilities coupled with adequate manpower to the problem of sugar beet technology.

Looking further into progress of sugar beet technology and passing into the factory itself the first operation is the slicers. How fully is the effect of chip quality on diffusion elimination known? How sure is anyone as to what represents the optimum chip? Everyone is reasonably sure that a good chip is tied into high elimination, but to our knowledge the details from there on are lacking. Certainly the cheapest purification that will ever be devised in beet processing is diffusion elimination. It, therefore, seems axiomatic that the industry should understand fully the mechanics of chip preparation and diffusion itself.

Now, moving on to diffusion itself. Where can you find well substantiated information on the following?

1. Effect of temperature of diffusion on the elimination of various classes of nonsugars.
2. Effect of time of diffusion contact on the elimination of various classes of nonsugars.
3. Effect of degree of exhaustion on elimination.
4. Effect of return of process waters on elimination.

Several more variables of diffusion could similarly be listed. A similar set of questions could be set up on the beet end purification steps of heating and carbonation, etc., which cannot be answered with any more certainty.

Why after so many years of operation is the physical and chemical behavior of this sugar beet and its products so much in doubt? Why is this sugar beet still viewed as being imbued with mystical properties by many operators? Such mystical associations have always been related to a lack of understanding or fundamental knowledge.

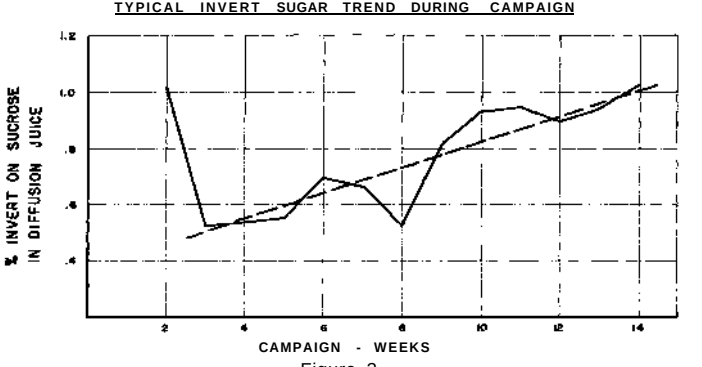

Figure 3.

An examination of the various reported studies on phases of sugar beet processing leads to the conclusion that the fundamental reason why such conflicting, confusing, indecisive reports have been forthcoming on many factors of beet processing has been the attempt to evaluate these problems on a factory basis. This is particularly true where the differences looked for are small.

Two very major problems confront anyone attempting the evaluation of a variable on a factory basis.

The first is the variability of the raw material itself. This variability is demonstrated in Figures 1, 2, 3 and 4. These graphs are based on weekly composites sampled on two or four hour samples. They demonstrate the

characteristic campaign variability of four important constituents of sugar beet liquors—namely, ash, invert sugar, amine compounds and total non-sugars. These graphs demonstrate a wide random deviation from week to week, superimposed on a basic rising trend in all cases except that of the amine compounds. It should be remembered that these are weekly composites, which will tend to iron out some of the variability occurring from hour to hour and day to day.

The second major complication in making comparative studies on a factory basis is the multiple internal cycles in the highly integrated sugar house balance. An example of the extreme variation which may result from shifts of these internal cycles is the variation in amounts of nonsugars which are returned to higher grade products via raw sugar. Circumstances have been detected where with poor raw sugar up to 40 percent of the nonsugars passing through the raw pan are returned to process via the raw sugar. On the other hand, with well purged raw sugar, this figure goes to 5 percent or less.

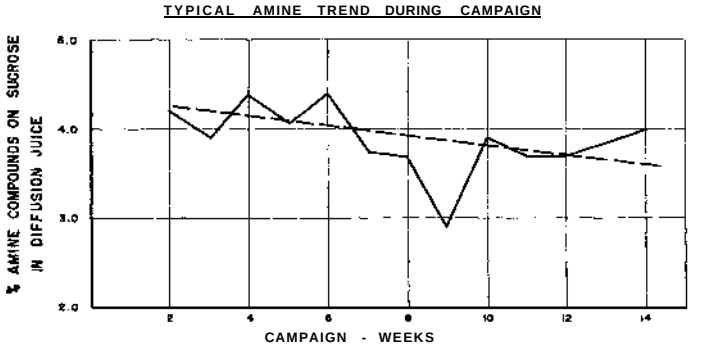

Figure 4.

An examination of the problem presented by this wide process variability as demonstrated above leads to the conclusion that an unwieldy number of repetitions and a maze of statistical analysis is necessary to reach a valid conclusion of even one small variable of sugar beet processing. We are faced with the need for answers to a large number of such problems.

There does appear to be a much shorter road to answering these problems and that is establishment of adequate pilot plant facilities for sugar beet studies.

In planning for any such pilot plant facilities, consideration should be given to planning for control of all variables involved in the problem.

Too many examples are on the books of sugar beet studies which were doomed to failure before they started because the equipment was poorly conceived and inadequately developed.

Due to the variability of sugar beet materials much of the pilot plant work will require preparation and preservation of sufficient quantities of a single sample so that this may be divided into a several of aliquots so that a series of variables may be run on a single source material. When this is done and all of the surrounding conditions are held constant with the exception of the one variable being studied, then—and only then—can real confidence be placed in the results.

Fortunately the availability of refrigeration equipment for rapid cooling or freezing of sizable quantities of samples, and the advent of many effective bacteriostatic and bacteriocidal materials which do not interfere with the studies, has simplified this problem of holding sufficiently large samples of materials for study.

Another factor which cannot be given too great an emphasis in planning for sugar beet processing studies is the preparation for adequate analytical control. Up to the present, inadequate analytical methods have seriously handicapped understanding of sugar beet processes. The analytical tools are now being placed in our hands for adequate analysis through such mediums as chromatographic analysis, but there are too few facilities in the industry to utilize them.

The considerations above bring us to the conclusion that only as the sugar beet industry obtains and adequately mans such pilot facilties will substantial progress be made. The improvements, obvious through casual investigation, are becoming lesser in number.