Amylograph viscosities of blends increased at all levels of substitution. The soya flour increased the dough firmness.

TEST SPAGHETTI QUALITY

The quality characteristics of spaghetti prepared with 10, 20 and 30% substitution of the animal proteins with soya flour are given in Table VII. In this test, the spaghetti having the best quality was obtained with pasta with 20% egg substitution by soya flour. These spaghettis had a better volume (4.4) than the control spaghetti (3.6) and a cooking loss of only 5%.

At 30% substitution of egg, pasta quality decreased. Pasta with dry milk replacer was of good quality at 10% substitution with soya flour. Spaghetti with 30% level dry milk substitution was not produced because of problems with stickiness at the press. Pasta with 20% egg substitution had excellent pastication and sensory characteristics; it was better than control pasta.

Particular Design Aspects of Very Large Extractors

K. WEBER, Extractionstechnik GmbH, Hamburg, West Germany

Three thousand MT/24 hr corresponding to 125 MT/hr means 100 big trucks per day. A shutdown of an extraction plant for 3 days having this nominal processing capacity corresponds, speaking in volume of beans, to a pyramid with a square basis of 30 m length and a height of 60 m close to the size of one pyramid in Gizeh/Egypt.

It is easy to imagine what the economical consequences are and what a nightmare for the plant manager an unexpected breakdown of an extractor in such a huge extraction plant means.

Therefore, concept and design of a plant of such size and the equipment used should eliminate all potential for breakdowns. That means that the expressions "redundancy" and "fail safe" should be headletters when conceiving such a plant.

When looking at the ship/truck unloading and loading system, the bean storage and conveying system for beans and meal, usually sufficient redundancy is existing, which means that a series of similar equipment handles the mass flow and a breakdown of one unit does not stop the whole plant but only reduces the capacity in accordance with the throughput of the failed unit. This redundancy usually also applies for the cleaning and preparation section because sieves, sifters, crackers and flakers that are available on the market can only handle a few hundred tons/24 hr. Therefore, rows of units are required to cope with the multithousand tons capacity. Some attention is to be paid to the conveying system to warrant a certain redundancy by using at least two, instead of one, conveyor to handle the mass flow between the different sections of the plant.

Economic calculation has proved over the years that, from the viewpoint of investment, energy savings and operational costs, a huge extraction plant for soybeans is a more profitable alternative than two or three separate extraction lines in parallel. Therefore, the design of a large extractor and the matching desolventizer-toaster should have integrated the same reliability and redundancy, although they are single units, as provided in the seed pretreatment equipment.

Another important aspect is the hazardous atmosphere generated in the extractor during operation, which means that not only the net time required to repair a failed element, but a multiple of this time is necessary when the hexane gas must be removed. Besides the imminent danger, additional loss of solvent and required fire protection measures must be considered.

The design for a multithousand ton extractor should: (a) locate all movable parts such as bearings, drives and similar elements outside the hexane atmosphere to provide easy access and changeability. (b) Provide sufficient redundancy for such parts as well as easy access without the need to empty the extractor when those parts must be replaced when it is physically impossible to place such movable parts outside. (c) Use external drives in such a number that the

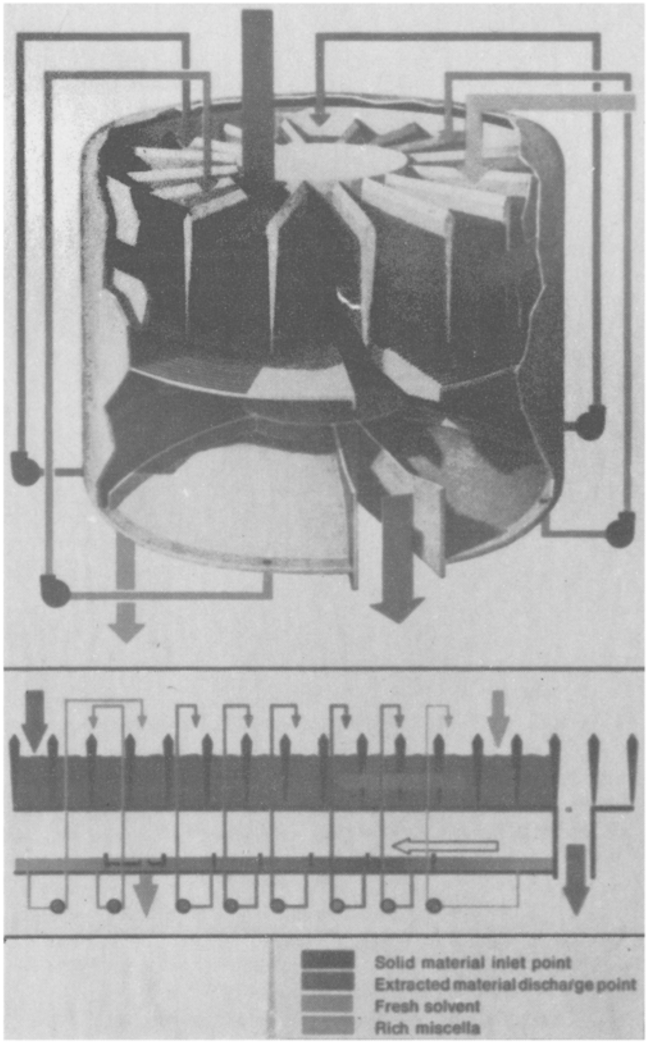

FIG. 1. Material flow through the carousel extractor.

failure of one or two will not directly affect the operation of the extractor. (d) Provide self-supporting construction to allow transport to the installation site in one piece on waterway, if feasible, or an easy assemblage to allow transport to the site in pieces by road or rail, and short term, on-site erection.

The basic concept we used to design an extractor for 3,000 tons/24 hr with a diameter of 15 m and an effective volume of 260 m^3 was that of the carousel extractor. Essentially, a carousel extractor consists of a cylindrical vessel divided into two sections by a stationary, wire-edge, slit bottom with concentrically arranged slits and prismatic wire sections with an open section for dropping the exhausted flakes; it has a multicell rotor positioned above the slit bottom to transport the flakes from the feeding point to the discharge point (Fig. 1). The bottom compartment of the vessel is the miscella collection chamber.

Besides the advantage that medium-sized carousel extractors have very few movable parts in the hazardous atmosphere, the self-cleaning, stationary slit bottom gives considerable operational advantages. To extrapolate a medium-sized extractor to a 15-m diameter unit, we had to find a new construction method to comply with these established rules.

We started with a foundation wheel as the basis for the whole construction (Fig. 2). The spokes of this wheel carry the slit bottom (Fig. 3). The conical hub of this basic platform carries the shaft and central wheel of the rotor, which is supported by bearings with automatic lubrication located underneath and outside the hexane atmosphere where it is easily accessible. The partition walls of the rotor, similar to wings, are supported by the central wheel and peripheral ring rolling on series of castors with self-lubricating bushings.

A linear, geometrical extrapolation does not give a linear stress function; therefore, the whole structure and all parts under stress were checked by the computerized finite element method in a computer program. The deformation/stress of vital construction elements were computer plotted under simulated heavy-duty performance conditions, enabling the designer to exclude weak structural links from the very beginning.

The rotor is driven by 6 hydraulic cylinders equipped with retractable carriers which push the rotor by action on the lapping pushing cycles in 2 groups that are controlled by a hydraulic unit with standby pump.

After a test-run in the workshop, the extractor can be easily dismantled and transported in pieces to the site, where it is reassembled on a foundation ring (Fig. 4). The reassembled extractor is insulated on-site. If waterway access is possible, the unit can be transported in one piece.

Comparing the compliance of this extractor design with previously described construction rules, it can be noted that: (a) the only movable parts in the hexane atmosphere subject to possible wear and tear are the castors supporting the drive ring. The number of available castors is greater than required and easy maintenance is safeguarded through matching access holes, so that they can be replaced from outside if necessary without lengthy interruption. (b) only 4 drives are required. Therefore, 2 drives can fail without interrupting operation of the extractor. Furthermore, these drives are completely independent units which can be replaced in a couple of hours. (c) The hydraulic pressure generating and controlling system is equipped with a standby unit. (d) The miscella distribution showers are placed on the extractor roof and have sufficient covered holes so that any clogging can be removed by simply shutting down the corresponding miscella pump and cleaning off the shower from outside.

So far, extractors running under these operational conditions have proved the validity of this overall approach.

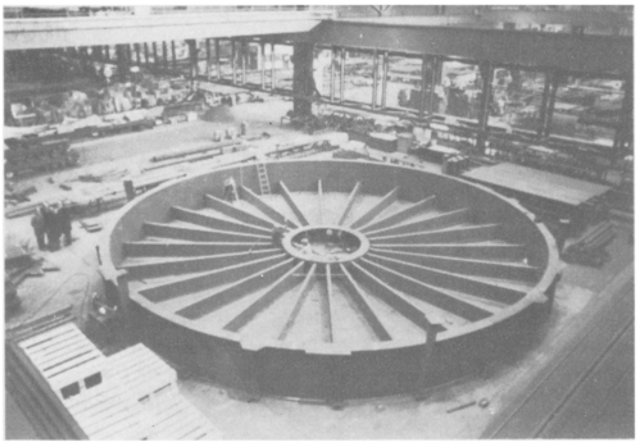

FIG. 2. Foundation wheel.

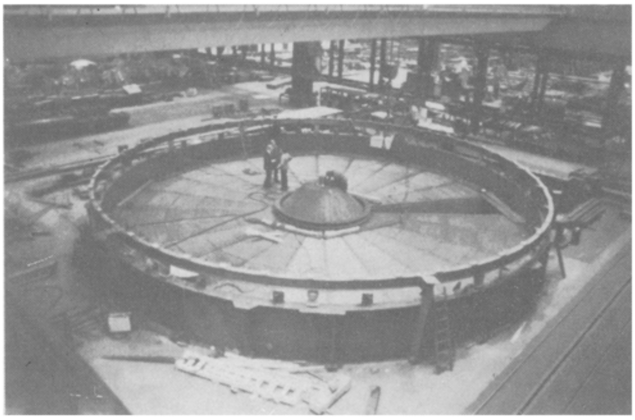

FIG. 3. Slit bottom.

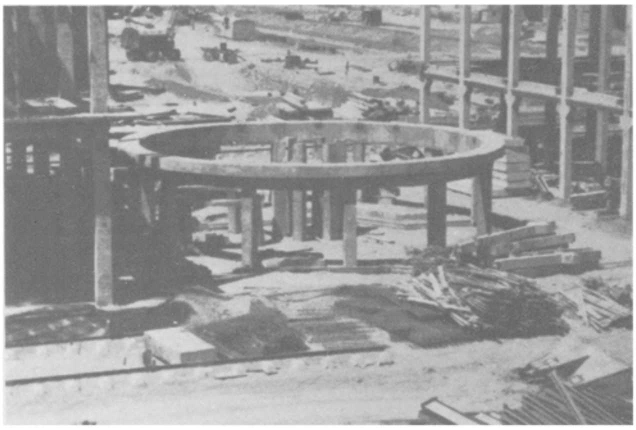

FIG. 4. Foundation ring.