Preparation of Safflower for Solvent Extraction

ALFREDO GARCIA-SERRATO, Los Molinos, S.A., Ciudad Obregón, Sonora, Mexico

ABSTRACT AND SUMMARY

Safflower is a high oil content seed. Its total moisture is low because of its high oil content. When safflower is conditioned for extraction by heating, wetting, and breaking, the volume increases and the resulting mass is fibrous and resists conveying. These characteristics determine the preparation conditions for safflower prior to solvent extraction: moderate moisture, moderate temperature, and adequate conveying. In direct extraction of safflower, operating capacity is decreased because of lower throughput at the flaking operation, and uniform conditions must be maintained in the preparation in order to avoid variations affecting the results of the extraction plant. Another problem of direct extraction of safflower is the large amount of fines in the miscellas at the extractor and in the full miscella. In prepressing and extraction of safflower, the seed is not cracked until it is pressed into cake in order to avoid conveying problems. The prepressed safflower cake is hydrated and sized for optimum extraction and solvent recovery from the meal.

The purpose of the preparation of all oilseeds prior to solvent extraction is to give the seed or meats kernel the exact conditions of temperature, moisture, size, thickness, and consistency for the extraction operation. A well prepared seed must have the best physical characteristics and conditioning as it goes into the extractor so that during the extraction time, the extraction solvent will penetrate it, dissolve the oil, and remove the oil in solution as the solvent drains out of the meats bed. Meats preparation and conditioning affects drainage time, extraction efficiency, oil quality, meal quality, and solvent loss in the extraction plant.

The purpose of oilseed preparation for most oilseeds prior to solvent extraction is to produce a moist and warm flake of oilseed meats which will be thin enough to be extracted quickly, by which will have the toughness to withstand conveying and extraction without crumbling into fines which will make percolation difficult.

While producing meats with the right conditions for extraction, the preparation room must supply the plant with a clean product and at a very constant flow according to the plant capacity. It must provide all these conditions continuously if it is to be a well run operation. This is difficult because such conditions of the incoming seed as moisture, amount of trash, temperature, and even size can vary. Also, in a preparation room working around the clock, there are three different shifts in charge of the operation, and this can cause variations, especially if the evaluation of the conditions is left to operator's observations.

PREPARATION OF SAFFLOWER SEED

Safflower seed has some characteristics which distinguish it clearly from a number of other oilseeds, when preparing it for solvent extraction.

(a) Safflower is a high oil content seed. Typically it contains around 37% oil. For this reason, safflower is not humidified or cooked as much as other seed conditioned for direct extraction. It is not dehulled, chiefly because in high oil content seeds, a large amount of oil tends to impregnate the hulls as the seed is conveyed, cracked, or otherwise handled. Consequently, the loss in oil would be considerable if the hulls were separated and not extracted.

(b) Safflower usually contains large amounts of foreign matter. This consists mainly of large sticks and dried flower fragments which are very light in weight. Two percent trash in the farmer's truck load of safflower can mean a large volume of trash. For this reason, there must be a good scalper at the beginning of a well designed preparation room for this seed, with an efficient way of disposing of this light trash.

(c) A third point about safflower is the toughness of its hull. This is another reason that it has not been dehulled successfully on an industrial scale. As more pressure is applied to crack this seed for a good separation, more oil is impregnated in the hulls.

(d) A final important point in designing the proper conveying equipment is the low density and high shear resistance of cracked safflower kernels. Once the seed is broken or cracked, the resulting mass is hard to convey and to get through tight spots because it does not slide or shear easily. Steep angles must be used in chutes or connections with ample conveying, in order to insure good tonnages through the equipment.

A typical density for whole safflower seed is 580 g per liter (44 lb per bushel). Cracked safflower runs lighter than this.

PREPARATION FOR DIRECT EXTRACTION OF SAFFLOWER

Both direct extraction and prepressing followed by extraction have been used by processors on safflower. At Los Molinos, we have used both methods for several years. In direct extraction preparation, we first clean a measured amount of safflower coming into the preparation room. The flow is regulated by a variable speed drive screw conveyor under the day run bin. Cleaning is done in two stages. First through a scalper for removal of large trash through a large, ½ in. square mesh screen and aspiration. The second cleaner has a two deck ¼ in. mesh screen and front aspiration. It removes smaller trash and dust.

The seed is then cracked on two high cracking rolls to insure that no whole seed reaches the extractor. The cracking rolls can be adjusted in order to get almost 100% cracked seed by applying only a light cut on a well adjusted set of rolls. Excess cracking at this point can result in excess fines in the extractor and fines in the oil. For these reasons, cracking is one of the most critical operations in the preparation of safflower for direct extraction. A U.S. 10 Mesh screen is very convenient for measuring the size of the cracked kernels. Optimum operation is obtained when 30 to 35% of the cracked kernels are retained on the U.S. 10 Mesh screen. Safflower moisture balances around 5 to 6% in the Yaqui Valley, and, after cracking, the kernels are raised in moisture for conditioning in order to reach the flaking rolls at ca. 9% moisture. In order to obtain this moisture, they have to be raised to about 10.5% after entering the stack cooker.

Through the cooker, the temperature is raised so that the lower two vessels maintain 70 to 75 C. If the temperature is raised above this, safflower will start to release oil going through the flaking rolls. After conditioning, the kernels are passed through flaking rolls, in order to have

thin pieces of material, although not exactly flakes as in soybeans. The flaking rolls attempt to produce a thin film of fibrous and oily material. This material should have a thickness of 0.012 to 0.016 in.

The hard hulls keep the flaked material from getting very thin. The residual oil in the safflower meal at the extraction plant varies directly in proportion to the amount of load passed through the flaking rolls. For a residual oil of around 1.0 to 1.5% the capacity of a 42 in. long set of single stand rolls seems to be around 40 to 45 T/D of whole safflower, as compared to around 120 tons for soybeans. This is one of the chief drawbacks of safflower processing by direct extraction.

PREPARATION FOR PREPRESSING SAFFLOWER

Prepressing safflower has the advantage of removing around 70% of the oil by mechanical extraction in a relatively simple operation, and also, avoiding some of the problems of conveying broken or cracked safflower.

After the safflower is measured and cleaned, it enters a conditioner for raising the temperature to 90 to 95 C and the moisture to 9%. This conditioner feeds the presses, where a cake is produced with around 16-18% oil and 6% moisture. This cake must be soft and pliable and it must have no whole seeds. This cake is then broken and conditioned again for optimum extraction. It can be broken in cracking rolls or in a hammermill.

The broken cake is then conditioned in a stack cooker and passed through wide open flaking rolls in order to produce a moist and warm granulated material with as few fines as possible. This calls for around 8 to 9% moisture and 60 C temperature. The granules should be about pea size, without making excessive fines. If the pieces are too large or hard, the hexane solvent will not have time to penetrate them and remove the oil. Also, there will be high hexane loss in the plant, since there will not be enough heat and time in the desolventizer to evaporate all the solvent from large or hard pieces.

A set of flaking rolls will process about 100 to 120 metric tons per day of prepressed cake and produce a good quality, easily extractable material. For this reason most plants prefer to run safflower by prepressing and extraction.

In this discussion, the assumption is made that the mill running safflower has been running soybeans, cottonseed, or other oilseed and that the conventional equipment for running these seeds is available for safflower preparation.

SPECIAL PROBLEMS

Safflower tends to disintegrate once the oil is extracted from the seed. For this reason, extraction of safflower oil causes fines in the miscellas, which the extraction system must be able to handle in order to run efficiently. The conditions of operation must be controlled closely in the preparation room to minimize variations in miscella drainage and varying amounts of fines in the extractor. The amounts of fines in the extraction system at any time is an indication of conditions in the preparation room.

Each type of extractor is capable of handling a different amount of fines in the miscellas successfully. In the types of extractors which can handle a lot of fines, one must be conscious of the large amount of fines which will remain with the full miscella. Those types of plants usually provide for filtration of the oil or at least decanting of the miscella in order to produce good quality oil and to avoid choking and clogging the evaporators.

One last item to observe in the design of a good preparation room for safflower is to provide ample capacity and horsepower for conveying the light, fibrous broken material.

[Received October 26, 1976]