NSI's New Sunflower Oil Plant

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ABSTRACT

Several new concepts for processing sunflower seed have been introduced in the new sunflower oil plant with 1500 ton/day capacity in Enderlin, ND. These are described and advantages discussed in this paper.

Universal Seeds and Oil Products (USOP), a major international company in the field of oilseed processing, was commissioned to design and build a sunflower oil factory with a capacity of 1500 ton/day in Enderlin, ND. The name of the factory is National Sunflower Industry (NSI). Based on our previous experience centered specifically on sunflower seed, we will present our principal considerations for the new factory.

The unloading capacity of the plant is very high (300 ton/hr) to enable discharging the railway cars and trucks in minimum time.

For storing sunflower seed, the most important factor which must be considered is the moisture of seed. The average oil content of sunflower seed in North Dakota is 40%, but the new hybrids now being developed will bring this up to 45% in the near future. The hygroscopic balance depends on the oil content of the seed because we measure the moisture in weight percentage relative to the whole seed. Oil is not hygroscopic and we have to consider the water content of the seed in relation to the nonfat parts of the seed. If the oil content is higher, the nonfat part is smaller, and in this case it is clear that the seed moisture must be decreased. The moisture of the nonfat parts of the seed is the "critical moisture". For sunflower seed, the critical moisture is 16%, but for good storage, we must use 15% maximum.

To emphasize the importance of the "critical moisture", Table I shows the moisture of seed with different oil contents.

TABLE I

Moisture of Seeds with Different Oil Contents

Oil content (%)	Critical moisture (%)	Moisture (%) (maximum in storage)
35	15	9.75
40	15	9.00
45	15	8.25
48	15	7.80

When the critical moisture exceeds 15%, the rate of respiration will increase. Respiration is accompanied by an exothermic transformation of the organic substances in the seed which creates conditions that can lead to spontaneous combustion of the stored seed.

After unloading, the humid, harvested seed is cleaned (not precleaned) by sifting and aspiration cleaners. After unloading, but before cleaning, there are 3 wet silos of 1000 tons each, in which the seed is sorted according to the moisture content. This will ensure more uniform drying.

A large drier-cooler supplied by Berico, USA, reduces the moisture to 9% and cools the seed to 18 F (10 C) above the ambient temperature.

The seed is stored in 10 silos with a capacity of 30,000 tons, an automatic temperature control system and the possibility to recirculate the seed.

In each silo, there is a special discharging system so that it is usually possible to handle the seed on a 'first-in first-out' basis.

The front-end decortication of sunflower seed is an actual problem in the edible oil industry. The advantages of decortication are: it increases the protein content of the meal from 28-29% to 40-42%; by removing 18-20% hulls, the capacities of the flakers, expellers and solvent extraction are increased; less wear and tear on the expellers; better oil quality because oil from decorticated seed contains less waxes; and the hulls are a good fuel (1 kg hulls = 3,500-4,000 kcal/kg or 14,000-15,900 BTU). Burning the hulls in a sunflower seed factory can provide the whole steam consumption and almost all the electricity consumption.

Conditions for good decortication are uniform size of seed, cleaned seed, not more than 8% moisture, and seed without adhering hulls.

In West Germany and France, large factories that import sunflower seed have front-end decortication because the oil content of the hulls is very high. It is known that the hulls are porous and absorb oil from the kernels during handling. For this reason, it is advisable to locate sunflower oil factories near the fields, and in the factory, to use chain conveyors even for short distances to avoid friction of hulls and seed kernels as far as possible.

In the NSI decortication plant, we will obtain 8-11% hulls in kernels and 1% kernels in hulls. By removing 18% hulls from the seed, the oil (including waxes) losses vary between 1.5-2.0% of the hulls, and 0.25-0.35% of the seed.

For the NSI plant we decided to install Buhler-Miag decortication with double separation. To obtain the optimal moisture of seed, we have installed a second dryer-cooler after storage and before decortication. After cleaning and drying, the seed is fed into 10 dehullers with an average capacity of 150 tons each (including the 15% return of undecorticated seed). The mixture of hulls, kernels and undecorticated seed is separated by 10 double MTMA separators.

The clean, aspirated hulls are sent to the steam boiler and the portion passed through the aspiration channel and through the lower sieves, is led to the 2nd-stage hull separation, which is similar to the first stage which in our case is another series of 10 double separators. Fine kernel particles are aspirated with the hulls of the 2nd-stage separation and therefore these hulls are passed through a sifter to recover the fines, and the hulls will also go to the boiler house.

After decortication, the meal will be flaked to ca. 0.35 mm. This should open the cells of the seed and after cooking and pressing, only a cake breaker is used for the preparation before extraction. Flaking will be by 4 large Buhler flakers, 2000 × 800. For conditioning the seed before pressing, we had to decide between classic cookers (10 units with 6 steam-heated pans with sweeps) or a rotary steam

tube unit consisting of a rotating drum with internal steam heated tubes. Although the rotating drum is cheaper and uses less energy, we decided to take for sunflower seed the classic cookers (6 compartments) which in our experience is better because:

- The conditioning regarding moisture and temperature can be adjusted better.
- Residence time is considerably longer.
- There is more independence in the distribution and continuous functioning of each press.

For pressing, we have provided 10 presses which give cakes with 15% oil content. To work efficiently with a low energy consumption, the meats are conditioned to 102 C and 4.5% moisture.

After pressing and breaking, the cake is extracted in the TOM extractor type 2500 × 50. This extractor is specially built for materials with dust/fines such as those produced in extraction of dry-degerminated maize germ, sunflower cakes, etc. The main advantages of the TOM extractor are:

- Immersion and percolation in the same extractor.
- Shallow bed
- Inversion of material at midway, to destroy the impermeable layer on the percolation area.
- Low utility consumption
- Mechanical simplicity
- Good emission control
- Fully continuous operation

The extractor is designed to operate with cake from totally decorticated, semidecorticated or undecorticated seeds. We have provided a desolventizer-toaster which ensures meal with a hexane content not exceeding 500 ppm. It is known that the desolventizing of sunflower meal is more complicated than soy meal because of the retention of hexane in the hulls.

The oil obtained by pressing, ca. 450 ton/day, is screened in vibration screens and then filtered in 2 horizontal AMA tank filters. We prefer horizontal tank filters to centrifugal decanters because in the decanters, 0.05% insoluble in ether remains, which is not filterable, and the energy consumption and maintenance costs are higher for decanters.

The extracted oil, ca. 150 ton/day, will be degummed in the extraction department and the gums reintroduced into the toaster. Although sunflower oil has less gums than soy oil, we prefer to degum the extracted oil—this will improve the oil quality and prevent foots in the tanks. The degumming system is also an important preliminary step for physical (steam) refining which we hope to introduce in the next year. For this reason we have introduced wet degumming with food grade acid and a flocculating agent.

Before bleaching, a phosphorus content of 5-8 ppm is obtained in the degummed oil so no more bleaching earth is needed than in the classic neutralization system to obtain 2 ppm or less phosphorus by bleaching with 0.5% bleaching earth. Next year we hope to complete the plant with a continuous bleaching system and physical refinery for 150 ton/day.

The desolventized meal is sent to the meal treatment and pelleting department. In this department there is a cooler, hammer mills and pelleting machines with a capacity of 30 ton/hr. For meal in bulk, we grind to 2 mm (1/12 in.) 97%. Pellets have a diameter of 6 mm (¼ in.).

The meal, or pellets, is stored in 5 silos. These are provided with vibrators for removal of meal and a recirculation system to prevent difficulties in meal storage. There is a loading system with a capacity of 100 ton/hr for trucks and rail cars. The meal loading station is followed by the oil loading platform.

The use of sunflower hulls as fuel for boilers has caused some serious problems—that of the actual burning and ecology. We have analyzed the hulls from North Dakota sunflower seed and found:

Moisture	:	7.81%
Ash	:	6.24%
Heating value	:	4000-4300 kcal/kg
Volatile matter	:	65.66%
Internal deformation temp	:	1050 C
Softening temperature	:	1093 C
Fluid temperature	:	1160 C
Ash analysis:		%
Silice as SiO_2	:	45.60
Calcium CaO	:	8.78
Magnesium MgO	:	5.48
Iron Fe_2O_3	:	1.25
Potassium K_2O	:	24.00
Sulfur SO_3	:	2.34
Aluminum Al_2O_3	:	5.92
Loss on ignition	:	3.62
Moisture	:	0.15
Sodium Na_2O	:	1.80
Others	:	1.06

The main problem that develops with burning hulls is a build-up of ash on the boiler tubes which in a short time reduces the heat transfer ability of these tubes and the steam output. Incomplete combustion in the furnace is the main cause of build-up on the tubes. To avoid this problem it is necessary to redesign the normal water-tube boiler for suspension burning of the hulls. In the boiler for burning hulls, it is necessary to have a higher retention time and a low heat release rate to obtain a better combustion.

The factory at Enderlin will have ca. 300 tons of hulls a day. For the plant we will need 20-30 tons of steam 12 bar/hr. From 300 tons of hulls/day we can obtain ca. 60 tons of steam per hour. The factory has 2 boilers firing on sunflower hulls and standby fuel oil. Each boiler of 70,000 lb/hr (31,500 kg/hr) is connected to two 2000 kW turbogenerators. In this situation, the factory has the possibility to burn all its hulls to ensure its steam consumption and all the electricity needs.

Since we are convinced that in the near future, sunflower seed with higher oil content will become available, we have allowed space for extending the cleaning and drying since when the oil content is higher, the seed has to be dried to 7-8% moisture.

This crushing plant, like others to be constructed in the near future, will contribute to increased cultivation of sunflower seed in the USA, the penetration of sunflower oil into the market and the improvement of the protein content of sunflower meal (42% protein and 12-14% fiber).

The increase of the oil content of the seed from 40-45%, as in the Soviet Union and other East European countries, will improve the yields and crushing margins of the new factories. Sunflower oil factories also have the advantage of saving energy because steam and electricity can be generated from the hulls and favorable outlets will be an incentive for the farmers to increase production.