Introduction
Since the 1980’s, many changes in the industrial application of drying lecithin have occurred. This paper outlines the changes in terms of capacity, moisture and color requirements, and GMO concerns. Also discussed are methods to deal with these changes as well as dealing with issues such as acid number, AI adjustments and environmental concerns.

Capacity
Until 1980, most evaporators sold for continuous drying were for Soy Lecithin plants processing 500-1200 short tons/day of beans. This equates for 225-500 kg/hr of dry Gums. A continuous drying plant of this size using thin film drying technology utilizes evaporators of 2 to 6 M$^2$ (of heat transfer area).

Today, most applications in North America for Soy Based Lecithin require a nominal 10 M$^2$ of heat transfer area. For Latin American applications, most applications now require 25-40 M$^2$ of heat transfer area.

Moisture Content
The wet gums from the centrifuge normally have a moisture content of 30-50%. Prior to calendar year 2000, most dry gum moisture specifications were <1% moisture. Today, the residual moisture specifications are <0.5% and can be lower.

GMO
Lecithin from Genetically Modified Soybeans was normal until 2000 and is still common in North America. South American Soy Beans are often certified Non-GMO and are processed in the same manner as the Soy Bean applications in North America. However, Non-GMO plants using non-Soy Oil Seeds such as Sunflower have smaller capacities and the gums can be more viscous than the traditional Soy Bean application.

What is a Thin Film Evaporator?
A Thin Film Evaporator allows for the continuous, reliable processing of viscous materials and heat sensitive products without degradation. Thin Film Evaporation separates water from Dry Gums/Oil using:

- Indirect heat transfer
- Mechanical agitation of a thin product film
- Vacuum
- Short residence time
- Open low pressure-drop configuration

Traditional Operating Conditions
- Heating Temperature - 162°C
- Product Temperature – 110°C
- Steam Pressure – 5.5 bar
- Vacuum - 50 mmHg g absolute
- Rotor Speed – 12 m/sec

There are many variations of the agitated film evaporator including evaporator orientation (vertical or horizontal), cylinder bore (tapered or straight), and wiper type. The wiper type is critical and must be a rigid type rotor as opposed to a wiper type. This is due to a vacuum cooling effect in the evaporator that causes a viscosity spike during the drying process.

A particular orientation and type of cylinder bore are often touted by manufacturers as having major advantages but experience shows that these are minor concerns. The decision to use a vertical or horizontal evaporator will have little effect on the final product. In either case, the residence time is very low. Often a tapered bore is touted to achieve lower moisture content...
due to a longer residence time in the evaporator. No evidence has been submitted to substantiate that claim. For residual moistures in the 0.5 to 1% range, the agitation is sufficient such that the final moisture is a function of equilibrium between the concentrate temperature and the vacuum applied. In fact, the additional residence time from the tapered body may cause unwanted color in the dry gums.

Considering the Batch Process Alternative

For years, the wet gums have been successfully dried in a batch process using a jacketed vessel with a special agitator heated with hot water. A batch system operates at low heating temperatures and increasing vacuum levels to produce a dry Lecithin gum with good color and low moisture content. Batch systems have the advantage of not being sensitive to incoming moisture levels. Very low moisture contents are achievable due to long batch times and increasingly deep vacuums. However, the disadvantages include long batch processing times, limited capacities, high operator supervision and the danger of a process upset damaging an entire batch. Batch systems are well suited for small capacities.

Most new installations are for larger capacities, and for this reason, are continuous. A continuous process can handle large capacities with a single processing line, produces a dry gum with low moisture (<0.5% in a single pass and much lower with two evaporators in series) with good color, and requires minimal operator supervision. As with any continuous process, the heating and condensing load are constant requiring smaller vapor handling equipment and a lower peak utility load.

Traditional Dry Gum Specifications
- Minimum Acetone Insoluble Content: 62%
- Maximum Moisture Content: 1%
- Maximum Hexane Insoluble Content: 0.3%
- Acid Value (mg KOH/g): 32
- Maximum Gardner Color (5% solution): 10

Today’s Requirements
- Dry Gums Moisture: as low as 0.2%
- Non-GMO Capable (High Torque Drives)
- On-line AI Adjustments
- Acid # Adjustments
- Environmentally Compliant
- High Capacities

To achieve dry gums moisture content of 0.5% or lower, a 2 stage process is recommended with the first evaporator operating at 50 torr and a second operating at 5 torr. To demonstrate why, let us first consider the case of using only one evaporator. For a single stage evaporator to produce a moisture content of <0.5% in the dry gums, an operating pressure of 25 torr and a minimum dry gums temperature of 100°C are required. To achieve moisture contents any lower than 0.5% will require either an increase in dry gums temperature which will cause increased color, or lowering the operating pressure which will make the peak viscosity almost unmanageable.

If we operate at 50 torr in the first evaporator, we can keep the dry gums temperature close to 100°C, and in the second stage evaporator (where there will be minimal flash cooling now due to lower moisture content), we can operate at 5 torr and achieve moisture contents in the range of 0.25% and maintain a dry gums temperature on 100°C. Because the second stage is operating in a mass transfer mode rather than a heat transfer mode, smaller evaporator sizes are required for this stage. The second stage is typically only 20% of the first stage in terms of surface area.
To maintain good color, the dry gums must be immediately cooled to 55°C. This is most commonly done with a scraped surface heat exchanger, but can also be done with a spiral heat exchanger if care is taken not to allow the gums to cool below the desired temperature and plug the heat exchanger. The scraped surface heat exchanger requires a greater capital cost, but is more forgiving in operation.

Other areas to consider when designing a Lecithin Drying system are the vacuum system and associated water treatment, Acetone Insoluble's adjustment, and Acid Number adjustment.

The vacuum system is typically a steam jet ejector system with a direct contact condenser. A direct contact (spray) condenser is normally recommended over a surface condenser to avoid fouling of the tubes by entrained organics. These organics can be removed by treating the overflow of the hot well. This oil water separation can be as simple as a decanter to remove any rag layer prior to sending the oil-contaminated water to the water treatment facility. If further oil separation is required, a coalescing filter can be used to reduce the oil to 50 ppm. If the water needs further purification (for instance, if the water were to be re-used as boiler feed water), this can be accomplished with a microfiltration membrane.

A thin-film evaporator can process gums with AI content up to 70%. However, most specifications are only 63% and the lower AI product is much less viscous and easier to handle. For this reason, the AI content is frequently adjusted by adding refined oil. This is frequently done prior to the feed of the TFE, or even in a second feed nozzle in the TFE since the rotor makes an excellent mixer. Care must be taken not to add too much oil considering that the Acid Number may need to be adjusted later on and this will also affect the AI.

Finally, the scope of supply for the vendor should be considered. A vendor able to supply skid mounted systems will typically have a lower installed cost, shorter delivery, faster ROI and lower risk compared to the client supplying this part of the system.