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Food Grade Phosphoric Acid in Turkey

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Abstract:

A Turkish company, A. B. Gıda (A. B. Foods) has built a food grade phosphoric acid plant in Bandırma, Turkey. The plant started-up successfully in June 2006 and is in current operation. The process technology package and portions of detailed design were provided by Prado & Associates of Tampa, Florida. The initial capacity was 18,000 metric tonnes/year and a current capacity expansion is planned. Most of the current output of the plant goes into sodium tri-poly-phosphate ("STPP"), also operated by A B. Foods. The plant features traditional solvent extraction technology, but with some improvements supplied by Prado & Associates. This paper will explore the details and history of the project. The timing of this project may be of great interest to the industry, since the technology utilized is similar to that of uranium extraction, which seems to have become a hot topic in view of the current energy situation.

In May 2002 a Turkish company, A. B. Foods (A. B. Gıda in Turkish) contacted us to acquire the technology for a food grade phosphoric acid plant using fertilizer grade acid ("wet process") as feed. A. B. Foods had been trading agricultural commodities for many years (like Cargill) and had built a substantial market in Turkey for food products such as grains. And like many other food commodity traders, they also dealt with fertilizers and animal feed supplements.

By the time we established relations with them, A. B. Foods they were already in the process of building an animal feed di-calcium phosphate facility in the city of Bandırma, which is located six hours by car from İstanbul and two hours by high speed ferry. This facility is unusual in that it does not granulate in the traditional sense. The reaction product, either mono-calcium phosphate or di-calcium phosphate or mixtures of both, is ground and then screened. The coarse fraction is sold in either 50 kg or 1000 kg bags or $20m^3$ tote bins. The fine fraction is fed to a pelletizer which produces uniform size granules, approximately 2 to 4 mm in diameter. So, the recycle ratio is 0. The result of this is that this "granulation" plant produces one tonne of final product starting from one tonne of reactor discharge material. So, unlike most granulation plants we see here in Florida, there is no recycle, no bucket elevators, no maze of conveyors, etc. The end result is that this plant, with a capacity of 70,000 metric tonnes per year occupies a fraction of the space required by a traditional plant. Because of the absence of recycling equipment, the capital cost is also a fraction of that of traditional granulation plants.

The next phase of the Turkish phosphate complex is the production of food grade phosphoric acid. This type of product is not produced at all in Florida. There is one plant in North Carolina, another in Louisiana, and another that recently shut down in Idaho due to technical problems. The problems encountered by the Idaho plant illustrate the challenges of producing food grade phosphoric acid. Food grade acid used to be produced by what is known as the "thermal process" employed in the past by at least two plants in Florida, and several in other parts of the U.S.A. The process consumes a great deal of energy and produces a large quantity of solid waste. Thus none of the thermal acid plants in the United States are currently in operation.

Thermal acid technology has been replaced by solvent extraction purification of fertilizer grade acid. The purification process was originally developed by the National Fertilizer Development Center in Muscle Shoals, Alabama over 40 years ago. The basic processes developed there have been taken over by various chemical producers and have been improved and refined. At this time, the most common process uses tri-butyl phosphate (TBP) in a kerosene solution as the extracting medium for P_2O_5. Many other solvents have been tried, and they all work to one extent or another. The process requires the use of liquid-liquid mass transfer equipment, such as mixer-settlers or extraction columns.

When Prado & Associates started working on the A. B. Foods project, we did extensive test work in both Turkey and our own laboratories in Florida to determine the optimum solvent. We tried various solvents such as butanol, pentanol (amyl alcohol), acetone and TBP, among others. The most successful were butanol and TBP/kerosene. In the end butanol, however, was rejected, however, because of high losses and flammability concerns. Our conclusion was that TBP/kerosene was "the least bad" solvent to get the job done.

It should be noted that the acid that our client will use is imported from the Middle East. Since the source of acid may change, we have attempted to build as much flexibility as possible into the design of the plant in order to cope with variations in acid composition. Past experience indicates that those food grade acid plants encountering technical difficulties did so because they were not able to process varying acid feed.

In addition to solvent extraction, the acid needs extensive pre-treatment to protect the integrity of the solvent medium, and after-treatment to reach the same level of quality as thermally produced acid. In fact, one dilemma we faced was that industry standards were set by thermal acid. To attempt to match those standards is, in our humble opinion, totally unrealistic. For example, most food grade acid is actually used as a food additive. The specification calls for less than 10 ppm Fe (iron). To reach this level requires a great deal of effort. But it is indeed ironic that many of the food products which incorporate food grade acid, also call for the addition of iron as a supplement! So we remove the iron only to put it back in later on!

In any case, as reflected by the recent shutdown of the purification plant in Idaho, the production of food grade phosphoric acid is a tough and difficult business. The process requires all kinds of pre-treatment, internal recycling, side operations and post-treatment, and it must all be properly balanced to work properly. The level of instrumentation and quality control is extreme, particularly when striving for impurity levels of less than 1 ppm in some cases. This may explain the cost differential between fertilizer grade acid ($300/ton) and food grade acid ($750/ton).

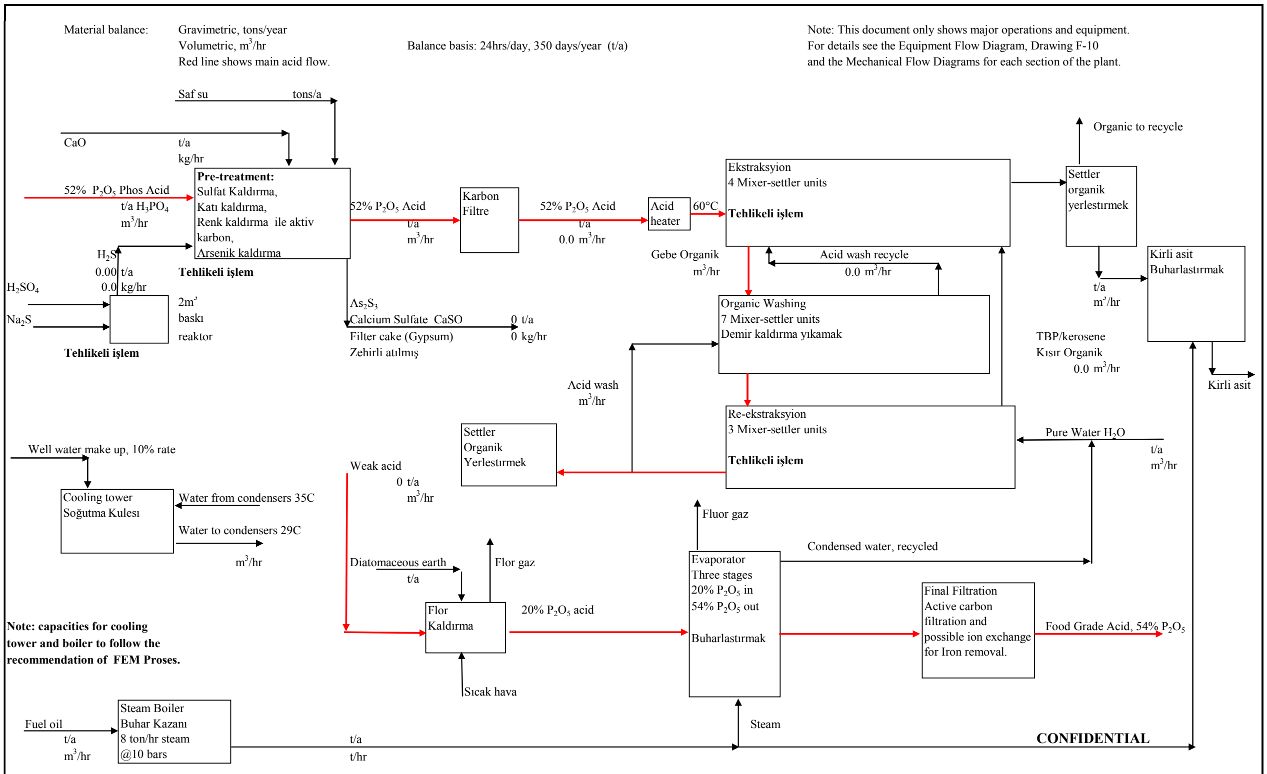
The design of our plant in Turkey features mixer-settlers instead of extraction columns. Columns have the advantage of taking up less floor space. However, they are more costly, since they would have to be imported, whereas the mixer-settlers were designed by Prado Technology and built in Turkey out of FRP. Also, extraction columns are dynamic systems, which require a great deal of fine tuning, are unstable and difficult to control, and are not suitable to changing process conditions. Furthermore, because of low labor costs, construction costs in Turkey were less than half of those in the USA and Europe. With the exception of some imported pumps, filters, and instruments, all the equipment used in the plant was built in Turkey. The plant has been designed in such a way that it will allow the production of various grades of purified phosphoric acid, including technical grade, food grade and pharmaceutical grade. Also, the layout contemplates the possibility of capacity expansion.

One important feature of the plant is the total automation. In spite of low labor costs in Turkey, automation is a critical matter in any modern chemical plant. In the specific case of food grade acid production, this even more critical due to the stringent quality control requirements. The analysis of the final product is done via ICP, with readings in the parts per billion (ppb) if necessary. Process control is done via a DCS and a typical screen picture is included in this paper.

Those of you in the audience who worked 25 years ago in the extraction of uranium from phosphoric acid will probably remember the rows of mixer-settlers, extraction columns, the formation of unbreakable emulsions, extraction coefficients, quality control problems, hydraulic problems, etc. Challenging! Fortunately, solvent extraction and acid purification are subjects that we know very well, and luckily, this project in Turkey was started up with little difficulty and is now running smoothly. Best of all, our experience can be extrapolated to the recovery of uranium from phosphoric acid, now a subject of great interest due to high energy prices and the resurgence of nuclear power.

During the successful start-up of the food grade phosphoric acid plant, a sodium tri poly phosphate (STPP) plant was also being built. Most of the output of the food grade acid plant will feed the STPP plant, with the remainder being sold in the Turkish market, where the demand is substantial. At present, a capacity expansion is in the works, with the aim of exporting food grade acid to the European and other international markets.

In summary, this project, while challenging, was very gratifying. The experience we obtained was invaluable and will allow us to boast of being one of the few engineering companies that was able to get a food grace acid plant going, under budget, and with excellent results. We hope projects like this will follow.



FOOD GRADE FOSFORİC ASİT FABRİKA	By:	FLP	12-Nov-02	A.B GIDA SAN. ve TİC. A.Ş. FOODS Inc.	PRADO & ASSOCIATES
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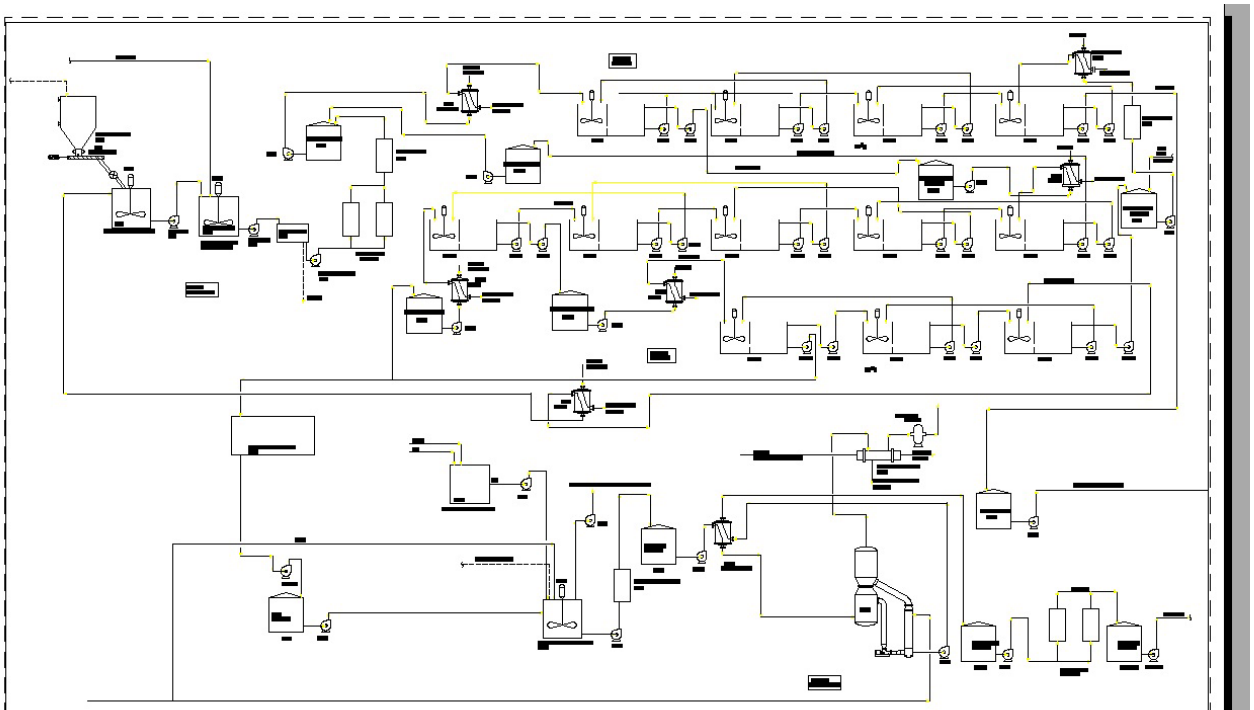

A. B. GIDA San. ve Tic. A. S.
BANDIRMA, TURKIYE
FOOD GRADE PHOSPHORIC ACID PLANT
PROCESS FLOW DIAGRAM

PRADO & ASSOCIATES
CONSULTING ENGINEERS
TAMPA, FLORIDA, U.S.A.

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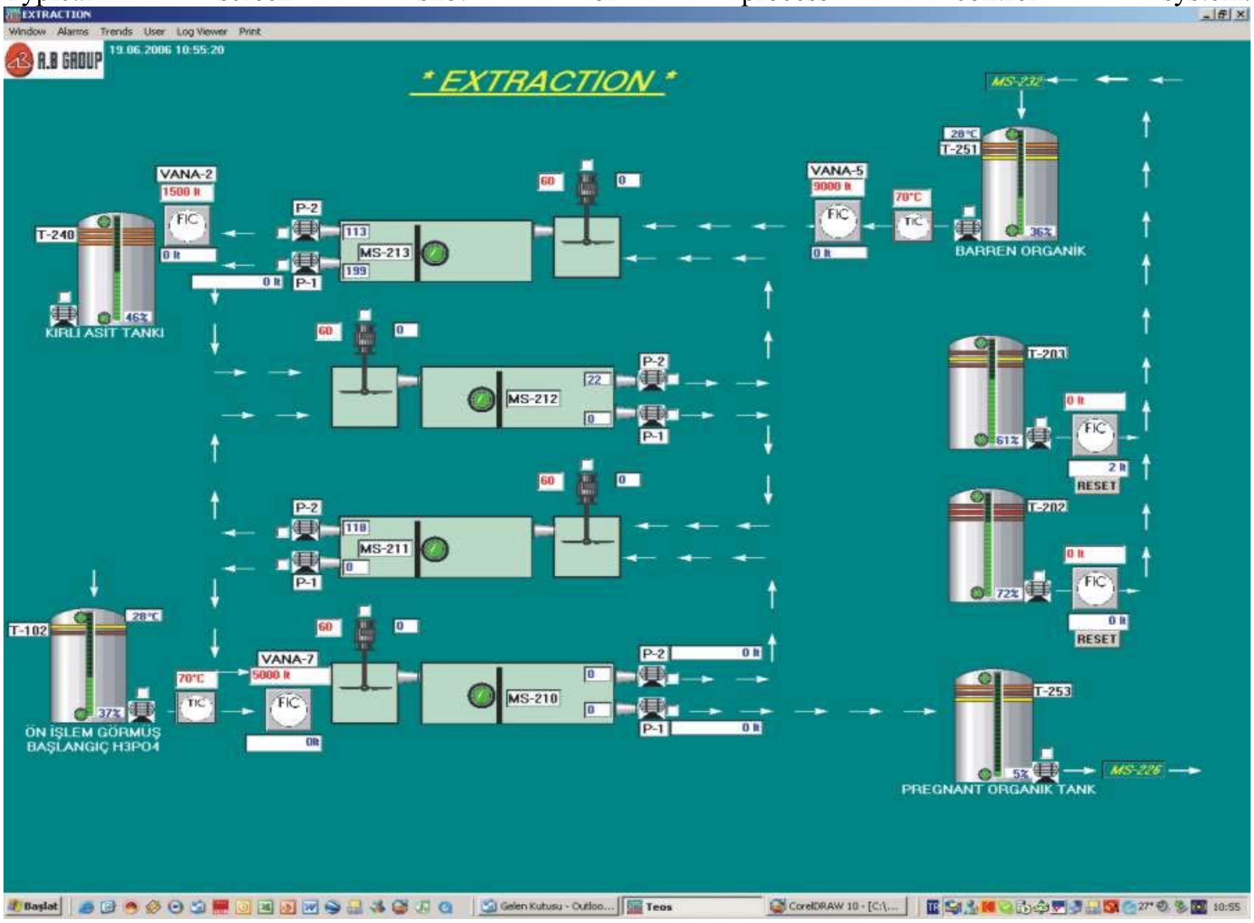
Typical screen shot of process control system.



Conventional Mixer-Settler Contactor