Revamp of CO_2 Stripping Urea Plant

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Overview

The urea plant of No. 1 Branch of Henan Jinkai Investment Holdings Group has two sets of 160.000 t/a urea plants using CO_2 stripping process, the first system was built in 2006, and successfully started up in the first try in May 2007. The second system was built in 2009, and successfully started up in the first try in January 2010, and the company made some revamp of the first urea line to allow the plant to operate safely and stably, save energy and reduce consumption.

Revamp in production

Convenient operation – adding emergency vent valve

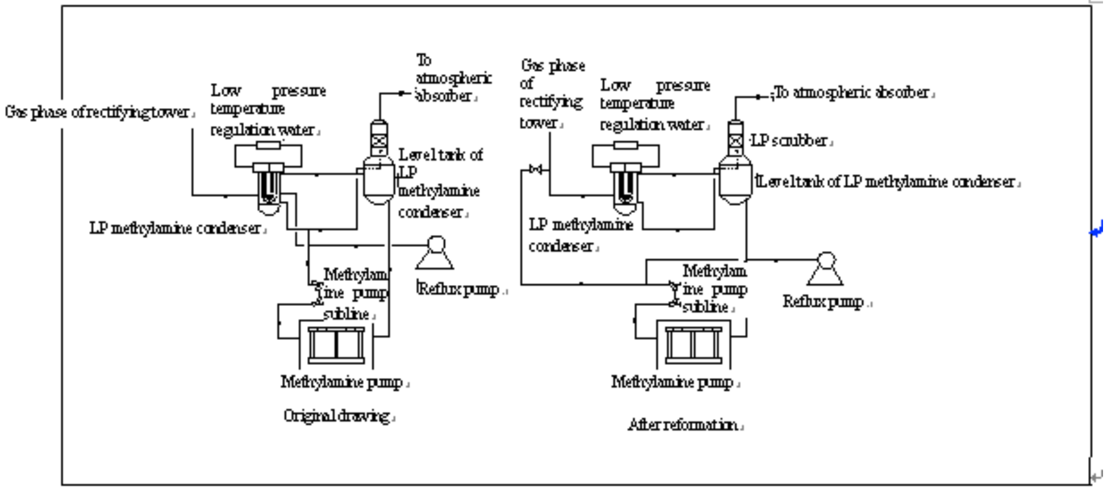
After the first line was put into production in May 2007, the HP system components can not be controlled properly due to unskilled operation, so that the concentration and level of the ammonia tank continued to increase, and condensate of the evaporation system can not be recovered, resulting in a vicious circle of the system which is difficult to adjust; secondly, if internal problem handling needs shut-down for synthesis draining or the previous system influence needs shut-down for synthesis draining and replacement, the synthesis must be drained due to excessively high level of the emergency tank, causing the situation of unavailable synthesis draining (excessive discharge resulting from overflow of the emergency tank); and desorber gas phase revamp of adding one emergency vent valve to the exhaust funnel was carried out during the shutdown overhaul in August 2007 to solve above-mentioned situations and facilitate operation. When the system is under a unstable state in production where the contents of NH_3 and CO_2 in the ammonia tank increase due to imbalance of ammonia/carbon ratio and water/carbon ratio, resulting in excessive desorption load (the volume has to be reduced to guarantee conformity so as to increase the level of the ammonia tank, inevitably resulting in continuous increase in the concentration and continuous worsening of the whole system), for which neither LP absorption is workable nor HP available, making the whole system difficult to be adjusted, the emergency vent valve can be conveniently adjusted so as to properly vent part of desorbed gas, and reduce condensation volume of the reflux condenser, thus reducing desorption load to ensure decreased level and concentration of the ammonia tank. Moreover, the hydrolysis and desorption system can be turned on to appropriately vent part of desorbed and hydrolyzed gas when the level of the emergency tank is high and shutdown for synthesis draining is required, thus lowering the level of the emergency tank, solving the problem of unavailable synthesis draining for replacement due to high level of the emergency tank, and avoiding the environmental incident of excessive ammonia overflow due to excessively high level of the ammonia tank or emergency tank.

Up-to-standard discharge and reduced consumption – revamp of sealing water for centrifugal pump.

Previously, the centrifugal pumps were provided with self sealing by using circulating water or some water pumps (the temperature can not be controlled, affecting life of the mechanical seals); however, leakage of some mechanical seals in production causes excessive ammonia in circulating water, affecting environment-friendly production of the company. Therefore, the unused underground tanks (collection tanks of materials discharged from various processes in the framework designed by the Fourth Design Institute of the Ministry of Chemical Industry, V=2.8 m^3) and underground tank pumps (for delivering materials in the underground tanks to the ammonia tank) were utilized during the shutdown overhaul in May 2008. The sealing water for all centrifugal pumps was recycled by the underground tank pumps, and discharged back to the emergency tank from pump outlets after reaching certain concentration, a small amount of ammonia was recovered, water was supplemented by the original steam condensate, one cooler was added at the pump discharge to adjust temperature (the temperature of the supplemented steam condensate is high, generally at 95 ℃, and has to be cooled to approximately 35 ℃), and then the water flew to all process pumps as sealing water. After the revamp, the life of the mechanical seals is extended from the original half a year to one year, some seals have not been replaced for nearly four years since the revamp, and the ammonia content in the discharged waste water drops from the original 50 - 80ppm to 10 - 30ppm.

Safe operation – revamp of pipeline from the discharge of the reflux pump to the LPCC

The pipeline from the discharge of the reflux pump to the LPCC was originally designed from the carbamate pump sub line to the LP scrubber re-feed line at the second floor to U-pipe of the LPCC. As the carbamate pump sub line is closed after the system is pressurized, and the carbamate pump operates stably without pump switch-over or shutdown, the carbamate pump sub-line is not used frequently, and there is no material flow, causing the carbamate pump sub-line to be blocked frequently, and posing a security threat to the start-up, shutdown and switch-over of the carbamate pump. The pipeline from the discharge of the reflux pump to the LPCC was diverted behind two valves of the carbamate pump sub-line at the first floor during shutdown overhaul in May 2008, one valve was closed and the other was open in production to ensure that liquid flew without dead end and prevent crystallization, then the pipeline was diverted from the carbamate pump sub-line to the gas phase pipe of the rectifying tower at the third floor, then the reflux liquid and gas were subject to absorption reaction directly in 300 mm (diameter of gas phase pipe of the rectifying tower) pipe, and flew to the LPCC for condensation. The low pressure of the pipeline from the discharge of the reflux pump to the LPCC is 0.25 - 0.3 MPa before revamp, and < 0.25 MPa after revamp, and ammonia consumption drops from the original 585 - 590 kg to 570 - 580 kg, with significant effect. Figures before and after the revamp are as follows:



Power consumption reduction

The process condensate pump was for supplying makeup absorption solution for the low pressure scrubber in the original design, but the consumption of such solution is very low (only 2 m^3/h in full load operation). However, both the process condensate pump and two feed pumps of the LP absorber operate in normal production, increasing power consumption. A communication valve from the outlet pipe of the feed pumps of the LP absorber to the outlet pipe of the process condensate pump was added during the overhaul in May 2008, then the process condensation pump can be shut down, only the feed pumps of the LP absorber operate, thus saving power consumption. Parameters: motor of process condensate pump: YB16M2-2WF1 15KW

The boiler feed pump was originally designed only for supplying makeup water for by product LP steam drum of the HP carbamate condenser; however, both the boiler feed pump and the steam condensate pump operate in normal production, resulting in a waste of power. Therefore, one communication valve was added between the outlet of the boiler feed pump and the steam condensate pump during the overhaul in May 2008, water is supplied by the steam condensate pump, and the boiler feed pump is shut down, thus saving the power consumption and reducing the cost after reformation. Parameters: motor of boiler feed pump: YB160M2-2WF1 15KW

Operation effect

The first urea line has seen significant improved performance in the nearly four years since the revamp, and the second urea line was directly modified during installation in 2009, and the second line was successfully started up in the first try in January 2010. The second urea line has reached expected effects within more than one year of production without security threat from blockage of the carbamate pump sub line and without discharge beyond standards, and the ammonia consumption is 565 - 575 kg.

Economic benefit analysis

Large equipment was not added, and stainless steel pipelines and valves were used in the revamp of the first line, with the investment of approximate 20,000 yuan (3,200 US$, June 2014 price level); however, the benefit generated is incalculable, as the loss of an accident (overpressure of the carbamate pump) is immeasurable; moreover, and consumption reduction brings better market competitiveness of the products.

Conclusions

Persons engaged in chemical production will find that there is no bagatelle in production, some escape, spill over, dripping and leakage will affect consumption, and reflect the management level of a plant. How to stably operate a plant at high quality and low cost for a long term will be one of the indicators for measuring process management level of an enterprise, some minor revamps in production are non negligible, and unsafe factors shall be handled and solved to facilitate employees' operation, create conditions for employees, optimize reformation, reduce consumption, lower the cost and improve the market competitiveness of the enterprise.

Translator notes:
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