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STUDY CONCERNING PROCESS RESTARTING AN AUXILLIARY COLUMN FOR ARGON/OXIGEN SEPARATION

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Abstract: *The paper presents the process for restarting an auxilliary column after an interruption in operation wherein descending liquid is stored during stoppage of the column. This auxilliary column is coupled with a principal air distillation apparatus in which is effected at least one oxigen/nitrogen separation. During the stoppage of the mean air separation column, the liquid contained in the auilliary column is stored, then this liquid is recycicled. During restarting an argon column, the liquid in the base of the column is mentained at a constant level. Collected liquid is used to re-inventory the separation section of the argon column with liquid before restarting that column or upon restart of gas supply to the column.*

Key words: *rectification column, entropy production, irreversibility mass and heat transfer.*

1. Introduction

A considerable amount of time is usually required to restart a cryogenic air separation plant following a shutdown or interruption, equipment problem, oversupply of non-condensable gas to a column, or an economic choice brought about by high power rates. When the vapour flow ceases in a distillation column the majority of the liquid, which was held up on the internal material by the vapour, will drain from the internals to the bottom of the column. The resulting liquid pool is of a composition intermediate between the column's top and bottom composition during normal operation. To restart the operation of the air separation column, liquid retained at the bottom is normally drained or is reprocessed to reestablish desired purity. By draining liquid from the sump in argon column, a considerable quantity of argon is lost. Because the argon is such a minor component in the air, a costly time delay occurs before the argon purity is reestablished when the plant or the argon column is restarted.

2. The Normal Operation of the Plant

In figure 1 is presented an air separation column for optaining oxigen, nitrogen and argon in gaseous phase. The atmospheric air compressed, purified and cooled to about its dew point, is introduced in the base of the medium pressure column 1 (which operates under 5-6 bars absolute), via the conduit 2. This column produce at its head medium pressure nitrogen, via the conduit 3. The air enriched in oxigen is sent from the base of the column 1 to an intermediate point of low pressure 4 (which operating slightly above atmospheric pressure), after expansion in

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an expansion valve 5. The almost pure liquid nitrogen is sent from the head of the column 1 to that of the column 4, after expansion in an expansion valve 6. The vaporizer-condenser 7 thermally couples the columns 1 and 4. It causes the liquid oxigen collected at the base of the column 4 to boil while condensing the gaseous nitrogen at the head of the column 1. The column 4 produces at its base low pressure gaseous oxigen, via a conduit 7, and at its head, via a conduit 8, impure gaseous nitrogen.

In normal operation, a mixture that is relativelly rich in argon and substantiallyfree from nitrogen is Fig.1 withdrawn from an intermediate point of the column 4 via a conduit 9 and is introduced in the argon column 10 below the distributor 11. The reflux of column 10 is ensured by vaporization in the condenser 11 of air enriched in oxigen, expanded in the expansion valve 12, controlled by the level regulator 13. The air enriched in oxigen thus vaporized at a pressure such that the gas resulting from this vaporization can be returned to the column 4 via a conduit 14 provided with a flow control valve 15.

Te gas enriched in argon from column 4 and supplying the argon column contains a little nitrogen. It can happen, during irregular operation of the column 4, that this gas contains substantally more nitrogen than intended. This nitrogen is in large part in the head of the argon column, where it concentrates in the gas which will be condensed, thus lowering its condensation temperature.

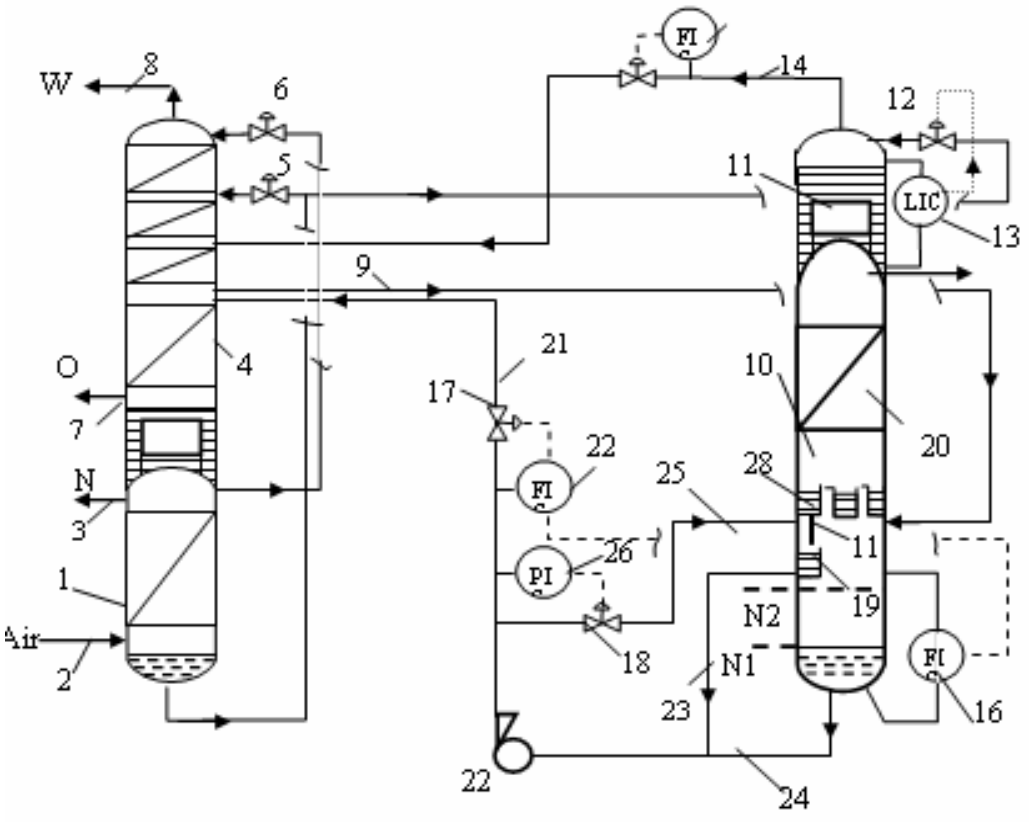

Fig. 1

As the pressure of the air enriched which vaporizes should not fall below a certain limit (because the vapor must be returned to the column 4), it results that the temperature difference of the condenser falls and can even disappear, giving rise in its turn to a reduction or even cancellation of the flow of condensed gas, and hence a stoppage of the arrival of gas rising in the argon column.

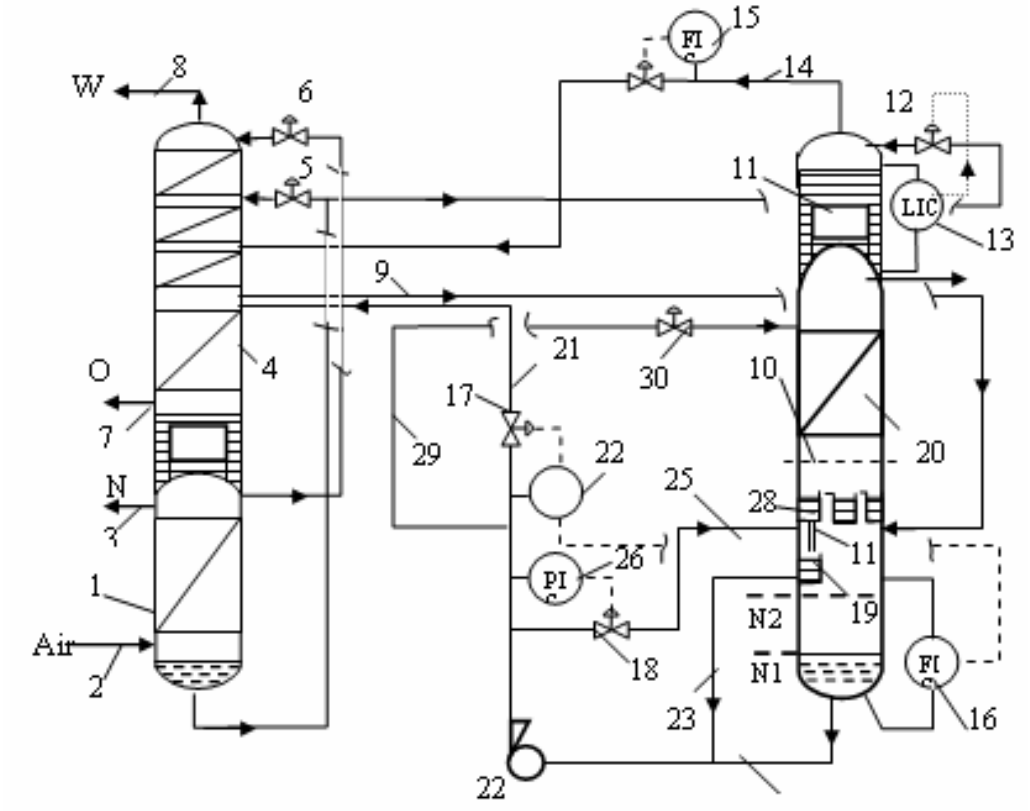

Fig.2.

The level controller 16 mantains a constant low level N1 in the base of the column 2, such that the valve 17 remains open for a flow rate equal to the flow rate of liquid condensed by the condenser 11, and the valve 18 remains closed, or else open for a constant overflow flow rate returned to the trough 19. All the liquid from the distillation section 20 is thus returned via the conduit 21 into the column 4. The inlet of pump 22 is freely connected on the hand to the trough 19 by a conduit 23, and on the other hand to the base of the column 10 via a conduit 24. The output of the pump is connected on the one hand to an intermediate point in the column 4 by a liquid return conduit 21 provided with a controlled valve 17 and on the other hand to the trough 19 by a recirculation conduit 25 branched upstream of the valve 17 and provided with a controlled valve 18, which opens when its upstream pressure reaches a predetermined value, thanks to an upstream pressure controller 26. The level of liquid in the base of the column 10 can be controlled at a value set by a level controller 16, which sends control signals to a flow controller 27 which controls the valve 17.

3. Process for Restarting the Auxilliary Column

To restart the column 10:

- The level N2 being set on the level controller 16 and the valve 15 being closed, the pump 22 is restarted. As no liquid is produced in the section 20, the valve 17 closes, and all the liquid output by the pump is returned, via the conduit 25 to the base of column 10;
- Then the condenser 11 is restarted by opening the valves 12 and 15. Gas is then condensed at the head of the column 10, which gives rise to the aspiration of gas via the conduit 9, and the liquid poor in oxigen enters the distributor 28 and, from there, the trough 19;
- The level N2 continuing to be set by 16, the pump 22 cannot output but the liquid poor in oxigen, via the conduit 23 and the valve 17, which opens upon the flow of this liquid produced in the section 20. The column 4 is thus not polluted by excesive argon;
- When the column 10 reach equilibrium, the level controlled by the controller 16 is progressively lowered from N2 to N1. This gives rise to the progressive and controlled return of the liquid rich in oxigen stored in the base of the column 10, to the column 4, and it is easy to control this process so as not to affect substantially the purity of the oxygen produced by the column 4.

In fig.2 we show a manner for reducing the height of the column 10.

In this modification, there is provided a supplemental return conduit 29 branched from the conduit 21 between the conduit 25 and the valve 17, provided with a normally closed valve 30 and connected to the uper portion of the distillation section 20. During stoppage of the column 10, the liquid level is mentioned high level N3. Before restarting, the valve 30 is opened and the pump 22 is operated. Liquid rich in argon is thus recycled in the upper portion of the section 20, and the level of the liquid in the column 10 falls to the level N2, while exposing the gas inlet from the conduit 9. In the course of this step, excess liquid can be returned via conduit 25 to the trough 19. Then, the condenser 11 is started, the valve 30 is progressively closed, and the valve 17, under the control of the level controller 16, opens to return to column 4 an increasing flow of liquid, which is necessary to maintain the level at the constant value N2 in the base of column 10. When the valve 30 is closes, restarting is effected as described above.

4. Conclusions

A method for restarting an auxilliary column for argon/oxigen separation is presented. This method has for its object to permit, during restarting the argon column, a semi-complete recovery of the argon without substantial pollution of the principal air distillation apparatus.

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