Design and Analysis of Raw Brine Supply of 2 000 t/a Bromine Extraction in North Sea - Salt Area

Salt Production

Key words: Bromine; region centralized control; global centralized control

Abstract

Some sea salt fields of northern China lackf efficiency for providing moderate brine (around 12 baume degree) to manufacture Bromine due to the scattered salt field structure. In this study, two measures were taken to give a better way to supply brine of 12 baume degree in the case of a 2000 t/a scale of Bromine extraction pilot. A moderate brine well and the corresponding pipelines were designed in each scattered evaporation pond of 12 baume degree brine to collect the moderate brine. Three blow-out columns and three absorption columns were constructed to allocate the brine optimally. Region centralized control and global centralized control were employed to convey the brine efficiently. The brine wells before and after the Bromine extraction were both 1.5km^2 and 1m in depth, which can guarantee the sufficient brine to produce 2000t/a Bromine. An automatic monitoring system was built based on Industrial Ethernet and the network system. The optimization control strategy and the automatic control of air blowing and Bromine distillation process were successfully realized by introducing the online image analysis technique.

1. Introduction

At present, domestic production enterprises in the North sea - salt area have centralized and decentralized saltworks. For Centralized saltworks, because bittern production areas are relatively centralized in centralized saltworks, it is only necessary to choose the moderate brine areas suitable for extracting bromine to build the bromine extraction workshops (bromine extraction plant). Because the decentralized saltworks structure is relatively decentralized and the sea water entering the beach will be directly dispersed to different crude salt groups, the middling concentration brine suitable for the production of bromine is dispersed to different crude salt groups. This makes it difficult to realize concentrated bromine extraction from the middling concentration brine. The price of bromine is both stable and provides a substantial profit margin. Because of this, sea salt production units are all implementing new projects to increase the production capacity of bromine. If decentralized saltworks can also extract bromine resources from salt making brines, it will bring considerable economic and social benefits.

2. Calculation and analysis of process planning

From the perspectives of process technology and economic feasibility, the extraction of bromine from decentralized saltworks adopts the middling concentration brine bromine extraction process

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which is widely used in domestic salt producing units. Meanwhile, the concentration of bromine raw material brine is 12 ° Be' and the bromine content is 240 mg/kg. If 2000 t/a of bromine production capacity is carried out, assuming a bromine extraction rate of 75%,11 million cubic meters brine of 12 °Be' will be needed. North sea - salt area has four distinct seasons. During general drying period (March ~June), 60% of the annual brine requirement can be produced.

3. Analysis of brine transport design

According to its long-term planning direction and the difficulty of technical transformation of salt field for the salt field of decentralized salt pan, there are two kinds raw materials of bromine extraction transportation methods, which are regional centralized transportation method and fully concentrated transportation method.

3.1 Regional concentration transportation method

3.1.1 Brine transport scheme

Sea salt production unit using regional centralized transportation method can divide the salt field into several regions (two regions as an example). In order to facilitate the management and production of bromine extraction, enrichment by dispersion blowing and concentrated distillation model are used. After the crude salt group brine has reached the concentration (12 °Be') of the bromine extraction, they are first stored in brine wells of raw salt group. Brine well and brine transportation pipeline branch is connected by the inspection well. Brine relies on differential pressure to flow into the branch pipe. The brine in the branch pipes meet in the main canal. This brine is collected in pipelines and concentrated in all regional brine reservoirs before bromine extraction. The brine in all regional brine reservoirs before bromine extraction is blown and enriched in the corresponding blowing absorption tower. The enriched brine first enters all regional brine reservoirs after bromine extraction and then is treated with neutralization. And then the enriched brine flows back to the crude salt group for salt making production through the trunk pipe and branch pipe. The enrichment is transported to the distillation tower through the main channel pipe and distilled uniformly. In the brine transportation and return process, according to the terrain and the transport single-line distance of saltworks, 1 ~2 steps water pumping device can be added.

3.1.2 Process flow chart (as shown in Figure 1)

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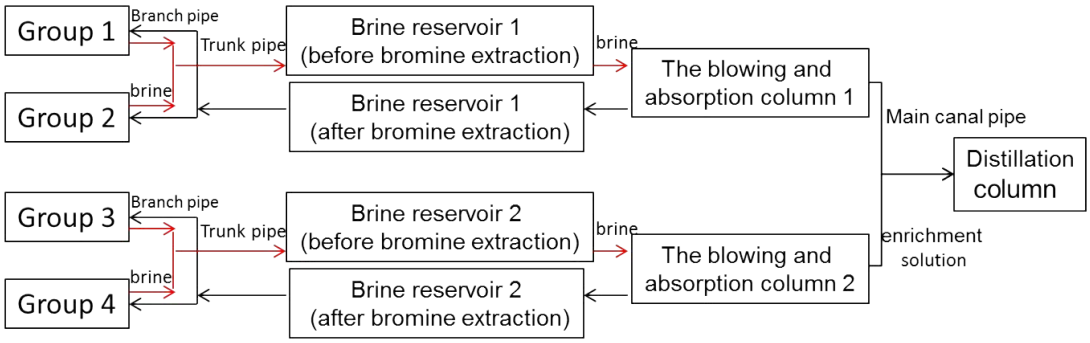

Figure 1. Process flow chart

3.1.3 Brine distribution design

The distribution of brine should be designed according to the principle of saving investment as much as possible and ensuring maximum benefit。According to the design of bromine extraction from all brine, three sets of blowing and absorption towers should be provided. In this case, the three sets of towers can be started for only three and a half months a year. For the rest of the time, a tower is in the discontinued production and depreciation. If two sets of towers are used for production, the concentrated brine can be stored temporarily in brine reservoirs for busy days and after the busy days, the extraction of bromine can be carried out. Some crude salt is lost on the year after the implementation, but this is much less than the high added value of bromine. If the amount of branch pipeline transportation in all regions of saltworks is counted by the amount of brine produced in groups, the maximum monthly (May) brine conveying capacity of the trunk pipe is 11.65 million cubic meters for the actual brine production. The maximum monthly transportation enrichment of main channel pipe is 5200 cubic meters of the enrichment needed for bromine extraction.

3.1.4 Pipeline design

The design scheme adopts pipeline transportation, which is designed as two-way pipeline for brine transportation and brine return. Non- pressure PE double-wall bellows are used as brine transportation branch pipelines and trunk pipelines. The flow of the pipeline shall meet the discharge for the total brine supply flow in the line for 24 hours. The diameter of the trunk pipe is 1 500 mm and the flow rate is 1600 m^3/h. The main channel is 100 mm diameter and the flow rate is 7.2 $m^{3/}$h. Because of brine transportation measurement and assessment, at this entrance and exit of the brine transportation pipeline, the electromagnetic flowmeter is installed, which is used for on-line monitoring of the flow rate of brine transport and return. Pumping stations are configured according to the size of the flow, and the flow rate should equal the channel flow.

3.1.5 Brine reservoir design

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In each region, reservoirs before extracting bromine and reservoirs after extracting bromine are designed. The stored brine content was 300 thousand cubic meters and the brine storage time was 10 days. After extracting bromine, the brine should be neutralized in the brine reservoir, then stay for a certain time after treatment and can be transported to salt making production. The area for reservoirs before extracting bromine and after extracting bromine is 1.5 square kilometers. The depth of brine reservoir is 11 m. All the brine reservoirs are covered with plastic film and covered with soil to prevent leakage. The reservoir after extracting bromine is for riprap protection, which can speed up neutralization of acid brine after extracting bromine.

3.2 Fully centralized transport method

3.2.1 Brine transportation scheme

Sea salt production unit using fully centralized transport method can divide the saltworks into two regions. After the crude salt group brine has reached the concentration (12 °Be') of the bromine extraction, this brine is stored in brine wells of the raw salt group. The brine well and brine transportation pipeline branch are connected to the inspection well. Brine relies on differential pressure to flow into the branch pipe. The brine in the branch pipe meets in the main canal and is collected in the pipeline and concentrated in all regional brine reservoirs before bromine extraction. The concentrated brine is transported to the bromine extraction workshops to carry out bromine extraction through the main brine channel. After the bromine is extracted, the brine is transported back to the reservoirs after bromine extraction through the main brine channel, in which neutralization treatment is carried out. Neutralized brine flows back to the crude salt group through the brine transportation trunk and branch pipeline. During brine transportation and return process, according to the terrain and the transport single-line distance of saltworks, 1 ~ 2 steps of water pumping devices can be added.

3.2.2 Process flow chart (as shown in Figure 2)

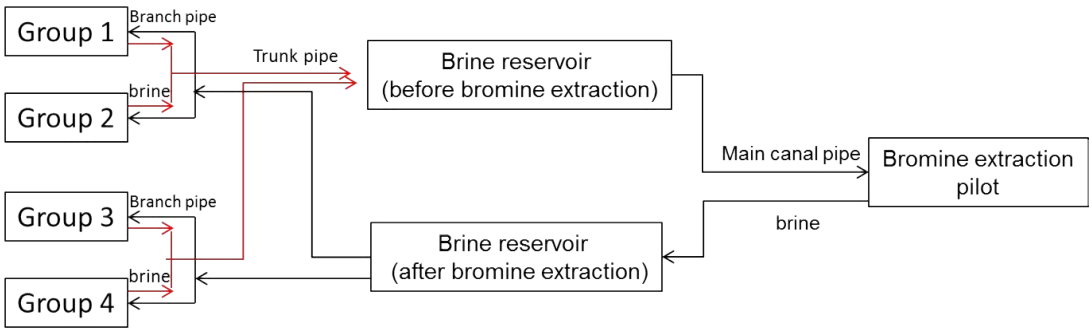

Figure 2. Process flow chart

3.2.3 Brine allocation design

The scheme is the same as the method of regional centralized conveying for the selection of the blowing and absorption towers and the distribution of brine. The design ideas are to choose two sets of towers and temporary brine storage for surplus brine. If the amount of branch pipeline transportation in all regions of saltworks is counted by the amount of brine produced in groups, the maximum monthly (May) brine conveying capacity of the trunk pipe is 11.65 million cubic meters for the actual brine production. The maximum monthly transportation flow of main channel is 1.728 million cubic meters of the brine needed for bromine extraction.

3.2.4 Canal design

The design scheme adopts pipeline transportation for branch and trunk canal, which is designed as two-way pipeline for brine transportation and brine return。 Non- pressure PE double-wall bellows are used as brine transportation branch pipelines and trunk pipelines. The flow of branch pipelines and trunk pipelines shall meet the discharge for the total brine supply flow in the line for 24 hours; The diameter of the trunk pipe is 1 500 mm and the flow rate is 1600 m^3/h; The design for main brine transportation channel is two-way open channel for brine transport and return. The canal is covered with plastic film and covered with soil to prevent seepage. The flow of the main canal should meet the maximum monthly discharge of daily brine output within 8 h. The flow rate is 8000 m^3/h. Because of brine transportation measurement and assessment, at this entrance and exit of the brine transportation pipeline, the ultrasonic open- channel flowmeter is installed, which is used for on-line monitoring of the flow rate of brine transport and return. Pumping stations are configured according to the size of the flow, and the flow rate should meet the channel flow.

3.2.5 Brine reservoir design

Reservoirs before extracting bromine and reservoirs after extracting bromine are designed. The stored brine content was 60 thousand cubic meters and the brine storage time was 10 days. After extracting bromine, the brine should be neutralized in the brine reservoir after extracting bromine, then stay for a certain time after treatment and can be transported for salt making production. The area for reservoirs before extracting bromine and after extracting bromine is 1.5 square kilometers. The depth of the brine reservoir is 11 m. All the brine reservoirs are covered with plastic film and covered with soil to prevent leakage. The reservoir after extracting bromine is for riprap protection, which can speed up neutralization of acid brine after extracting bromine.

4. Analysis of advantages and disadvantages

4.1 Regional centralized transportation method

(1) Advantages

For the regional centralized transportation method, due to the blowing bromine process break up

the whole into parts. Transporting and returning brine in the regions is convenient for controlling brine. If it rains, the brine can be quickly protected and the production can be resumed as soon as possible when the rain stops so that the production management of salt making is convenient. Because all the brine transport and return is transported by pipeline, there is no seepage loss in brine transportation; The seepage prevention of brine reservoir can effectively reduce seepage loss of brine.

(2) Disadvantages

Enrichment in many regions and disperse blowing bromine are not good for the comprehensive management of bromine extraction. All of them are pipeline transportation, which is difficult to operate and maintain.

4.2 Fully centralized transportation method

(1)Advantages

Fully centralized transportation method only needs to rebuild the salt field system to realize concentrated blowing bromine and concentrated distillation so that the production of bromine can be easily controlled. The main channel of brine transportation is by canals so that it is easy to maintain and operate.

(2) Disadvantages

The brine in the saltworks is first concentrated and then dispersed, which isn't good for regulation. If it rains, in production operation, it is not as flexible as regional method and will have relatively large loss. The main brine channel is transported by canals, which will cause salt penetration loss; If the pipeline is used, the flow is too large. But the selection of large diameter pipes will reduce economic benefits due to increased cost of reconstruction.

5. Conclusions

In conclusion, the regional centralized transportation method and fully centralized transportation method can meet the requirements of dispersed salt field 2000 t/a bromine production capacity. They have their own advantages and disadvantages. The method of regional concentrated transportation will result in the least loss of salt and bromine, which is a better scheme. If you choose fully centralized transportation method, lower concentration brine can be chosen to reduce the losses caused by seepage and precipitation. The disadvantage is to increase the cost of bromine extraction. The final choice between these two options should depend on the local regional development plan and its own salt field structure including reasonable supply schemes of raw brine.

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References

[1] Su Chuntang Bromine Dechlorination Absorbents New Processing Technology J. Journal of Salt and Chemical Industry, 2015, 44 (9): 27 -28.

[2] Zhang Deqiang, Dong Yingjie and Bai Ruixiang, etc. Successful Application of Automation Technology in Production of Bromine Extraction from Medial Concentration Brine J. Journal of Salt and Chemical Industry, 2014, 43 (12):4 -7.