Stator Cooling Water in Power Generation Plants

Introduction

Power Generation plants produce electricity by converting one form of primary energy (nuclear or non-nuclear) to motive power in order to drive generators and produce electricity. During this process, heat is generated in the generator stator coils. Efficient operation and effective energy conversion is significantly impacted by how well the coils of the stator are cooled by the cooling water.

The purpose of this Customer Application Brief is to describe how an effective cooling water filtration system will provide long term added protection of the fine cooling channels of the stator cooling system in order to greatly reduce unscheduled and costly shut-downs.

The Process

Kinetic energy from a turbine is converted to electrical energy by a generator. During this process heat is generated in the stator coils. To maintain efficient operation and energy conversion, the coils must be cooled to keep the stator within specified operating limits. The vendor commonly designs this into the stator plant by using very small diameter tubing closely coupled to the stator coils. The cooling medium is demineralized water - typically with a conductivity of <0.5µS/cm.

As the cooling water is pumped around the circuit, heat from the stator coils is reduced. The water is re-circulated in a loop through the ion exchange system to reduce dissolved minerals that can cause scale build-up and result in restricted or blocked flow. Evaporation and other losses are supplemented by the addition of fresh treated water.

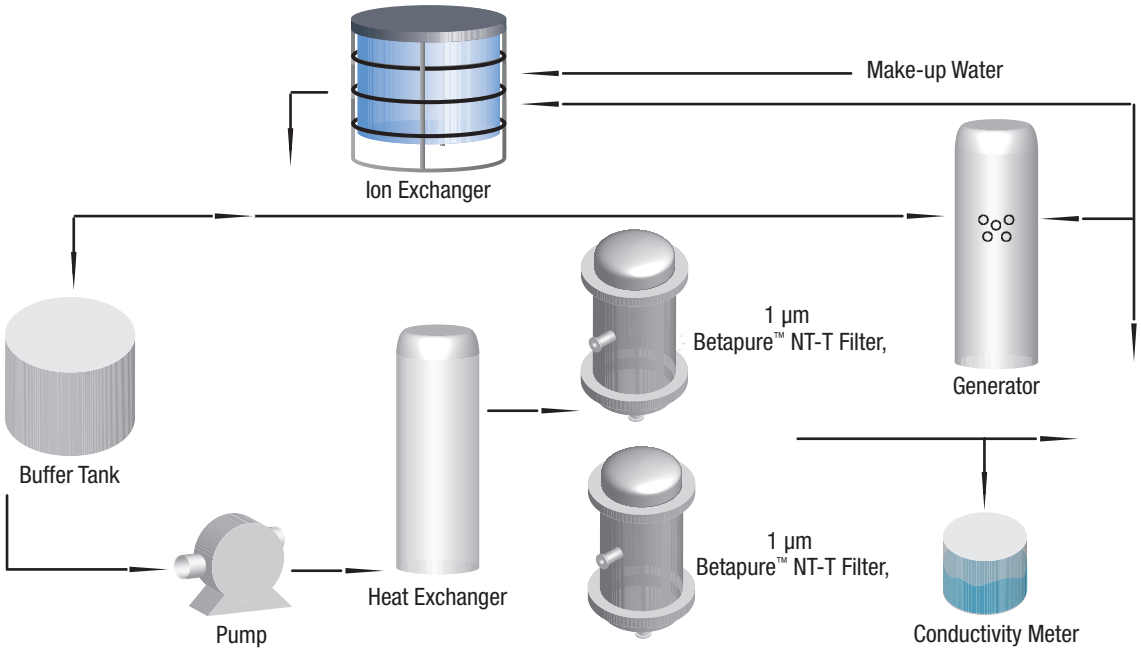

Figure 1 — Simplified Schematic of Cooling Loop Showing the Filtration Steps

The Problem

Contaminants entering the stator cooling water system are produced by scaling and corrosion of the cooling water piping, or they may enter with the make-up water.

Power Generation plants are most concerned with their ability to produce energy without system shut down and a reduction of unscheduled maintenance.

- Contaminants can foul the fine tubes that cool the stator coils which will reduce the flow through the tubes as well as lowering the thermal conductivity. As a result, the ability of the cooling system to transfer heat energy away from the stator is reduced and "hot spots" are created in those areas of the stator cooling coils that are most fouled. This ultimately causes the system to be shut down for cleaning of the stator cooling coils resulting in the plant not generating power and hence lost revenues. Unplanned shutdown can result in as much as $55,000 per hour in lost revenue.
- Unscheduled system shutdowns for change-out of filter cartridges results in the cooling water system having to be shut down and, therefore, the generator to be shut down. This means lost revenues.

The Solution

Filter Cartridges

The ideal filter cartridge for stator cooling water filtration is a rigid depth filter cartridge that will effectively reduce particles in the desired particle size range and will not unload previously reduced contaminant. In order to ensure the reduction of particles that can plug or foul the stator coils or the heat exchanger, reduction of particles 1.0 µm and larger is required.

In addition to it effectively reducing particles 1.0 µm and larger, the filter cartridge must also have very low levels of chloride extractables. Chloride, if not rinsed off the media, will act as a corrosion initiator in the cooling water system. High extraction rates of chloride and other ions from the filter media can cause long rinse up times resulting in longer downtime and lower revenues.

Betapure™ NT-T cartridges effectively reduce the contaminants that can foul the heat exchanger thereby ensuring effective heat transfer and minimizing generator shut down for maintenance. At the same time it allows for filter life to exceed the regularly scheduled maintenance cycles so that interim shutdowns are not needed. Betapure NT-T filters are also very low in extractables and will rinse up very quickly to specified levels.

The Betapure NT-T filter cartridge incorporates flow distribution channels and distribution netting allows contaminant to penetrate into the depth of the filter utilizing the entire depth of the filter. This provides long service life, fewer filter change-outs and reduced operating costs. Lower energy costs are also realized using Betapure NT-T. The unique design provides a significantly lower pressure drop across the filter reducing the energy required by the motor / pump to maintain the desired flow rate. The 1.0 µm absolute filter rating is consistent throughout the filter service life without unloading or shedding, even under pulsed conditions. Betapure NT-T is manufactured from virgin polypropylene using a process, ensuring a clean and efficient filter. Figure 2 shows the unique configuration of the Betapure NT-T filter media.

The utilization of Betapure NT-T filters on stator cooling water systems will provide:

- Reduced plant maintenance by reducing circuit cleaning operations.
- Improved filtration efficiency which results in longer service life of the plant.
- Fast rinse up leading to faster turnaround after filter change.
- Reduced use of treated water during rinse-up.

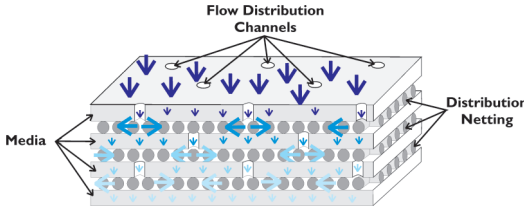

Figure 2 — Cross section of the Betapure™ NT-T Filter showing the flow channels which give contaminants access to media throughout the depth of the filter, ensuring the full capacity of the filter is used

Housings

3M™ Express series filter housings (Figure 3) are ideally suited for installation in stator cooling water systems. The standard housing is offered with 150 or 300 psi designs and can be easily configured for specific system requirements. Options such as outlet and cover lifting device location, radiography, and surface finish can be added onto the base model to create one of the most versatile filter vessels in the industry. The housing includes ASME Code stamp and National Board certification to assure the customer that all materials and fabrication procedures meet the most stringent requirements.

3M Purification Inc. recommends the use of two different housing sizes:

- Model ES20 – with (36) 40" long cartridges for a 660 gpm (150 m^3/h) system
- Model ES24 – with (52) 40" long cartridges for a 970 gpm (220 m^3/h) system

It is recommended to design the system with 2 housings in parallel. This offers flexibility by operating only one housing at a time and the idle housing can have the filters changed without process flow interruptions.

Figure 3 — Typical 3M™ Express Series Filter Housing

Suggested Recommendations

Utilizing our high efficiency filters as recommended in the 3M Purification Solution above has been proven to control the risk of scaling and restricting the very small capillaries of the stator coils. Unplanned shutdown could result in $55,000 per hour in lost revenue.

In addition to the savings in revenue through the reduction of unplanned maintenance shutdowns, the high contaminant holding capacity of Betapure™ NT-T filters allows for filter life to exceed regularly scheduled maintenance cycles so that interim shutdowns are not needed. The long on-stream life of the Betapure NT-T filter reduces the labor costs incurred during filter change-out.

Important Notice

The information described in this literature is accurate to the best of our knowledge. A variety of factors, however, can affect the performance of the Product(s) in a particular application, some of which are uniquely within your knowledge and control. **INFORMATION IS SUPPLIED UPON THE CONDITION THAT THE PERSONS RECEIVING THE SAME WILL MAKE THEIR OWN DETERMINATION AS TO ITS SUITABILITY FOR THEIR USE. IN NO EVENT WILL 3M PURIFICATION INC. BE RESPONSIBLE FOR DAMAGES OF ANY NATURE WHATSOEVER RESULTING FROM THE USE OF OR RELIANCE UPON INFORMATION.**

It is your responsibility to determine if additional testing or information is required and if this product is fit for a particular purpose and suitable in your specific application.

3M PURIFICATION INC. MAKES NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED INCLUDING WITHOUT LIMITATION ANY WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR OF ANY OTHER NATURE HEREUNDER WITH RESPECT TO INFORMATION OR THE PRODUCT TO WHICH INFORMATION REFERS.

Limitation of Liability

3M Purification Inc. will not be liable for any loss or damage arising from the use of the Product(s), whether direct, indirect, special, incidental, or consequential, regardless of the legal theory asserted, including warranty, contract, negligence or strict liability. Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation may not apply to you.

3M Purification Inc.
400 Research Parkway
Meriden, CT 06450, U.S.A.
Tel (800) 243-6894
(203) 237-5541
Fax (203) 630-4530
www.3Mpurification.com

70-0201-8647-7
REV 0911b