



Powder Technology
Division

introduction

Niro

Cleaning-in-Place of Spray Drying Plants



Introduction



Top view of the horizontal section of the FILTERMAT® spray dryer with side-mounted CIP nozzles.

The sanitary aspects of producing dairy and food products are of extreme importance. Plants must meet high hygienic standards to avoid product degradation and contamination during operation, and plant cleaning must be carried out quickly and thoroughly.

The use of CIP is becoming more and more widespread in the dairy and food industries, and Niro has developed PLC controlled systems to meet the present strict industrial requirements.

Sanitary design codes are the basis for the design of Niro powder plants containing liquid processing equipment (evaporators), spray dryers, and powder handling equipment (fluid bed dryers, agglomerators, coolers). The cleaning requirements are best met with cleaning-in-place (CIP) systems.

Liquid processing equipment such as evaporators, tanks, piping, feed preheaters and pumps (liquid or wet areas) is conveniently cleaned by circulating washing liquid and water.

Drying and powder handling equipment (dry areas) is cleaned by dry or wet methods, or a combination of both.

Dry methods involve the manual sweeping of all surfaces in contact with the product, or air sweeping by allowing a high velocity air stream to pass over the surfaces in question.

Wet methods involve either manual hosing of surfaces or use of remote-activated cleaning systems (CIP).

CIP Systems

The very nature of dairy and food products means that the possibility for product deposits forming on the surfaces of process equipment is always real. This is due to the fat, sugar and/or protein content of these products, giving hygroscopic and sticky characteristics at the temperature and humidity conditions present during processing. The longer the plant operates, the greater is the chance for deposit formation. Niro has successfully developed designs of evaporators, dryers and associated equipment that minimize deposit formation and permit plant operation over longer and longer periods of time. However, there comes a time when the plant has to be shut down for cleaning, and cleaning-in-place has become essential to minimize cleaning time and thereby maintain high plant production availability.

Niro has developed washing systems applicable to cleaning individual equipment items or a complete plant. These systems are based upon nozzles which are built into the plant components together with associated piping, fittings, and instrumentation.

A typical CIP flow sheet for a spray dryer of the tall form type is shown overleaf.

The CIP operation is normally computer controlled. A PLC programme controls pump and valve functions, and the cleaning sequences are given the optimum timing for efficient cleaning of all parts of the plant. The system is flexible in that different washing programmes can be applied.

An important part of and a condition for a well functioning CIP installation based on computer controlled operation is found in the professional commissioning of the equipment by Niro's experienced engineers.

The software foresees the possibility to alter and adapt the washing programmes according to experience and need when new products are processed, or new working conditions are applied. Furthermore, individual programmes can be elaborated for specific products which can influence cleaning efficiency, cleaning time, and the amount of chemicals to be used.

The commissioning comprises mechanical and process start-up phases, the latter being a programme start on one programme with optimization by a Niro software engineer.

Excellent cleaning results can also be obtained by a CIP operation based upon traditional sequence operated techniques. This is somewhat simpler and therefore has reduced possibilities for setting of process sequences. This simpler means of control has, however, certain advantages for the operator who is not familiar with computers or does not have the support of a qualified computer technician.



Preparing the feed line and high pressure nozzle atomizer for CIP cleaning. The operator places the nozzle lances in a tray, then attaches the pressure hoses before the cleaning cycle is started.



Preparing the spray dryer chamber for CIP cleaning. The turbine assembly mounted on the cleaning hose is brought into position at the top of the air disperser. To the left is seen the valving and liquid supply line.



Preparing the VIBRO-FLUIDIZER® for CIP cleaning by placing, at the powder outlet, a funnel which returns the cleaning liquid to the CIP kitchen.

CIP Equipment

CIP Kitchen

Different types of CIP kitchens are available for use in combination with a spray drying plant. Each type depends on dryer type, size and application. They feature single and multi-tank layouts designed according to the choice of liquid heating (direct, indirect) and degree of automation.

Two types of CIP kitchen are shown. A four tank system ensures a minimum of idle time between change-over from one liquid to another. The one tank system represents a low investment cost, but longer cleaning times are required.

Four Tank System

A CIP kitchen for a spray dryer featuring reuse of CIP liquid, recirculation of rinsing water, and indirect heating of liquid during the cleaning process.

The caustic and acid concentrations are measured during circulation, and liquid addition is automatic.

The CIP forward line is equipped with remote operated valves, pumps, and a tubular heat exchanger for heating caustic, acid and water to the required temperatures.

The return line is equipped with sensors and remote operated valves for returning of caustic, acid and water to their respective tanks or drain.

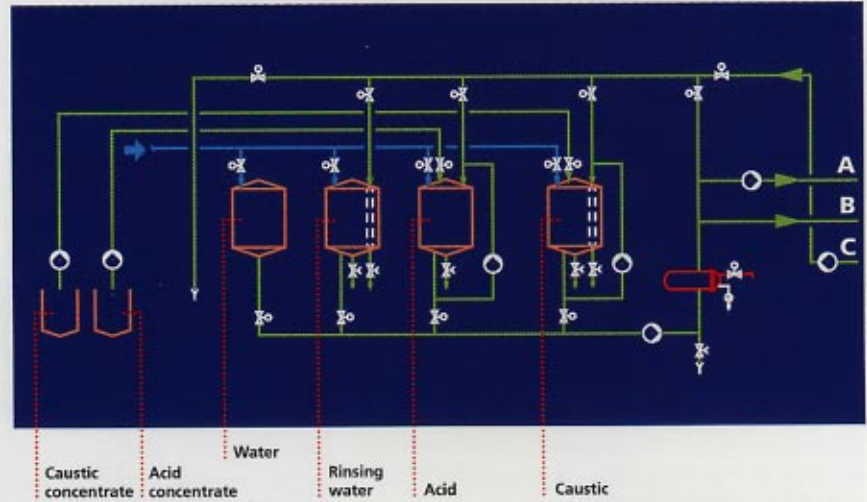
Concentrated caustic and acid are supplied from a dosing system comprising two dosing pumps located next to the tanks with pipe connections to the tanks.

Alternatively, caustic and acid can be supplied from an external central depot.

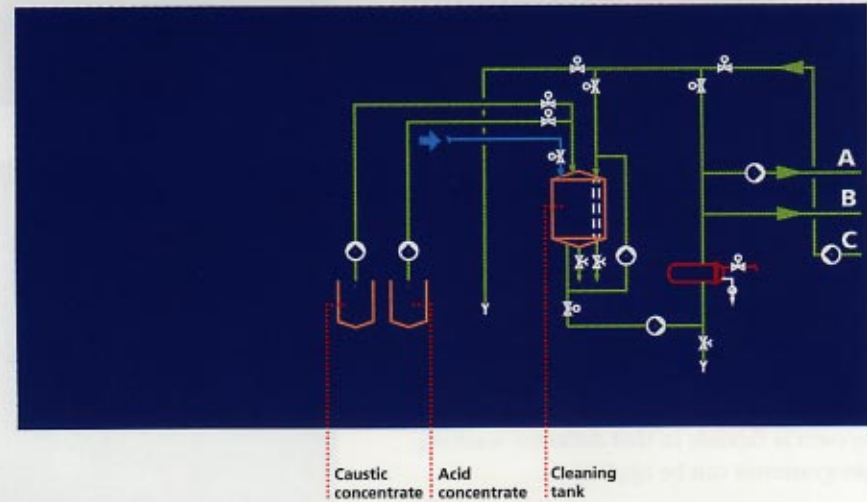
Single Tank System

Cleaning liquids are individually prepared before pumping to the spray dryer. Water and cleaning liquids are not reused after each completed cleaning cycle.

Four tank CIP kitchen



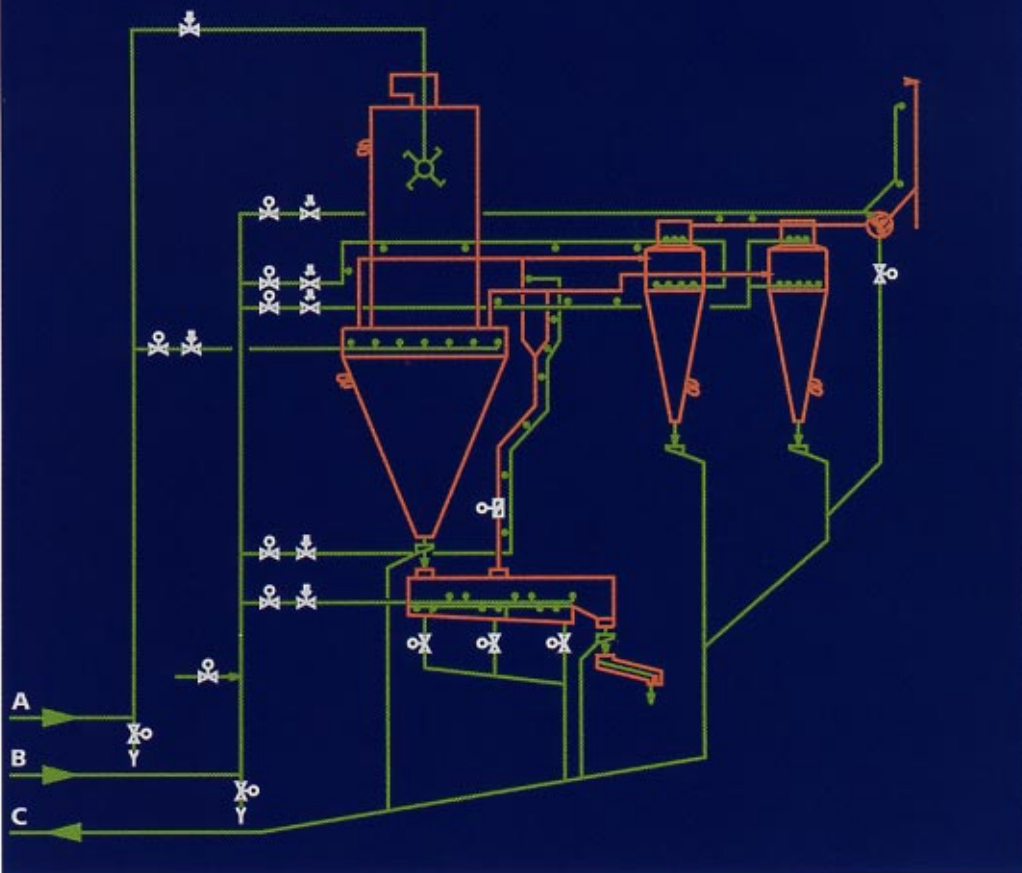
Single tank CIP kitchen



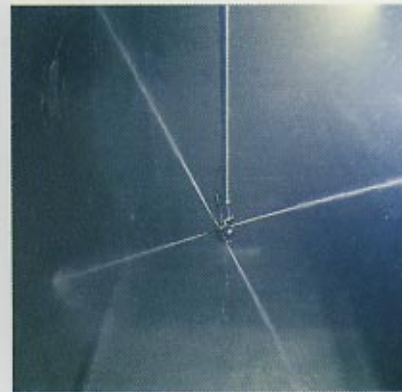
CIP kitchen comprising tanks for water, caustic soda, and acid.



CIP flow diagram showing a tall form spray dryer with VIBRO-FLUIDIZER®.



- A Cleaning liquid to the spray drying chamber
- B Cleaning liquid to VIBRO-FLUIDIZER®, cyclones, ducts etc.
- C Return line to respective tanks or drain.



The liquid jets of the unit offer an effective cleaning of the chamber surface.

Operation (Washing Programme) for a Four Tank CIP Kitchen

Water Cleaning

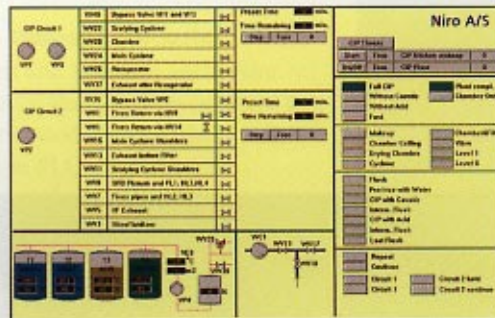
Water is pumped from the water tank through a heater to the cleaning turbine and/or to the CIP nozzles placed throughout the plant. The first liquid flush is normally sent to drain or to a separate collecting tank. The wash water is filtered and returned to the rinsing water tank prior to being reused. The washing procedure is repeated. The length of the washing period can be regulated by the PLC programming.

Caustic Cleaning

This next cleaning cycle involves a caustic solution as the washing medium. It is primarily used for cleaning where harder deposits have occurred. To enable repeated use of the caustic, separation of product solids from the liquid may be necessary.

Rinsing Cycle

A subsequent washing is achieved by switching back to the rinsing water tank.



Overview of a four tank CIP programme.

Acid Cleaning

From the acid tank, an acid solution is circulated for the final washing and neutralizing the caustic remaining on the surfaces of the plant. Acid cleaning, however, is always used in the wet processing areas, i.e. the feed system, tanks, homogenizers, and atomizers.

Clean Water Cycle

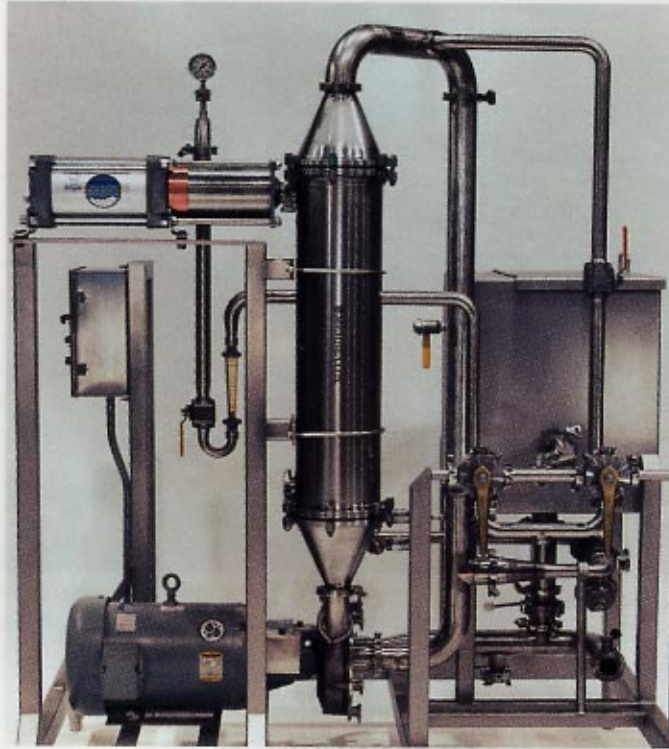
A final clean water washing is undertaken as the last stage of the cleaning process. Before start-up, the plant must be dried out. This involves switching on the air heater and fans to allow warm air to pass through the plant.

Chemical Recovery Unit, NCR

Niro's membrane filtration based NCR unit recovers caustic and acid used in the cleaning of dairies and powder plants. It offers significant advantages, especially where larger amounts of caustic and acid must be used.

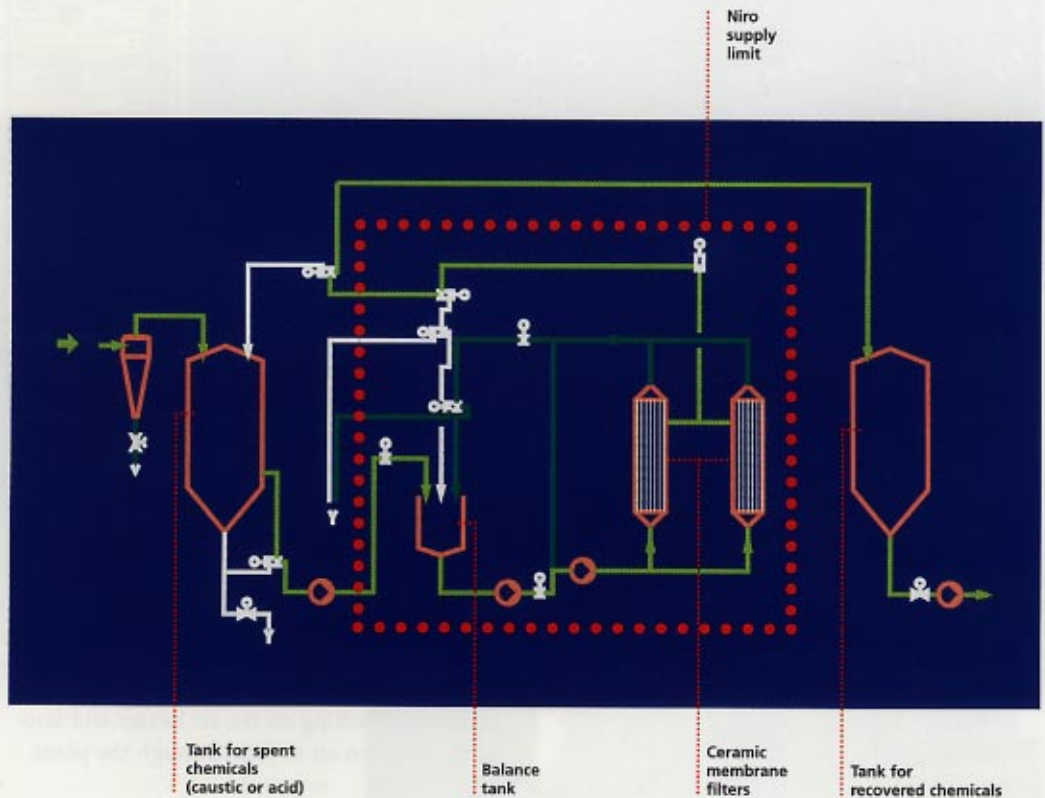
The NCR unit has a working cycle of 20 hours before cleaning and contributes to a considerable reduction in cleaning chemical costs.

The NCR consists of a ceramic membrane filter, feed pump, recirculation pump, and balance tank, and is linked by pipes and valves to externally placed tanks for spent and recovered chemicals.



NCR system with ceramic membrane filter.

Flow diagram showing a NCR unit with external connected tanks for spent and recovered CIP liquids.



CIP Nozzles



CIP nozzle, hydraulically activated. The nozzle is welded flush to the equipment to be cleaned. At sufficient cleaning liquid pressure the nozzle opens. A spring ensures the proper return of nozzle head.

Liquid Pressure Operated Nozzle

The nozzle is activated by the pressure of the cleaning liquid. When not in use, the nozzle head is in a retracted position, flush with the inner surface of the equipment requiring cleaning (spray drying chamber, cyclone, fluid bed, tanks, ducts, etc.). The nozzle causes no disturbance to the process in its retracted position, as no part protrudes to cause local turbulent conditions. During the CIP operation, however, the CIP liquid is pumped to the nozzle, causing the nozzle head to move out under the effect of liquid pressure. The Teflon nozzle head is now clear of the inner surface of the equipment. It begins to rotate and sprays liquid over the local area. Maximum coverage is achieved by the proper location of the nozzle, its capacity and operating pressure. Further details are given in a special Niro leaflet. When the cleaning operation is completed, the liquid flow to the nozzle is stopped. The nozzle head retracts to its original flush position. The nozzle is supplied for both insulated and non-insulated equipment.

Pneumatically Operated Nozzle

The nozzle design and function are similar to the above. However, the nozzle movement is pneumatically activated. The nozzle is especially suited to PLC operated CIP systems. The nozzle design is water-tight to 10 bar. The cost is higher than for the liquid pressure operated nozzle. The advantage is more flexibility, as each nozzle can be activated to open and close independently.



CIP nozzle, pneumatically activated. The nozzle is welded flush to the equipment to be cleaned. When activated, the pneumatic cylinder presses the spraying head into the vessel and liquid spraying takes place.



High efficiency cyclones equipped with CIP nozzles mounted in the top and around the main body.



CIP nozzles installed to clean the integrated fluid bed of the spray dryer and the attached vibrating fluid bed (VIBRO-FLUIDIZER®).



Air exhaust ducting and heat recuperation unit equipped with CIP nozzles.

