

# DAIRY

Process  
Technology  
for Dairy and  
Dairy-Like  
Products



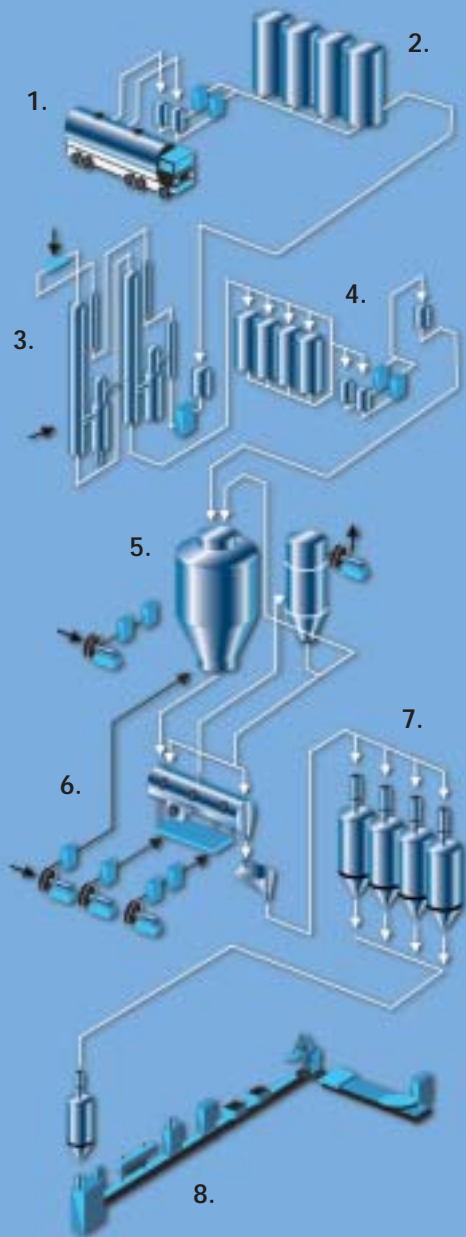
NIRO POWDER TECHNOLOGY

THE BONDS OF MILK ARE STRONGER THAN THE BONDS OF BLOOD

*Gaelic Proverb*



## From Milk Delivery to Finished Product



1. Reception
2. Storage
3. Evaporation
4. Feed system
5. Spray dryer
6. After treatment
7. Powder storage
8. Powder packing

## Products page 4-11

- Agglomerated Milk Powders
- Baby Food
- Whey
- WPC, Permeate, and Lactose
- Coffee Whitener

## Liquid Treatment and Concentration page 12-13

## Spray Drying page 14-16

- Compact Spray Dryer
- Multi-Stage Dryer
- Tall Form Spray Dryer
- FILTERMAT® Spray Dryer
- Integrated Filter Dryer

## After Treatment page 17-18

- Fluid Bed After-Dryer/Cooler

## Powder Handling page 19

## Sanitary Design page 20

## Safety Precautions page 21

## Customer Services page 22

## Financing page 23

The full range of dairy and dairy-like products – all processed in Niro plants

#### **Milk**

- Butter
- Buttermilk
- Cream
- Crystallized whey
- Milk permeate
- Milk protein
- Skim milk
- Whole milk

#### **Whey**

- Acid whey
- Demineralized whey
- Lactose
- Sweet whey
- Whey, delactosed
- Permeate
- Whey protein concentrate (WPC)

#### **Formulated products**

- Baby food
- Cappuccino
- Cocoa milk with/without sugar
- Coffee whitener
- Fat filled milk
- Fat filled whey
- Ice cream
- Milk replacer
- Whippings

#### **Other**

- Casein
- Caseinates
- Cheese
- Condensed milk
- Fermented milk products
- Hydrolyzed dairy products
- Yoghurt



Thousands of Niro dairy plants operate daily all over the world. Our engineering ranges from single pieces of equipment to complete plants, handling milk all the way from reception through liquid processing, evaporation, and drying to final bagging off.

#### **Know-how through R&D**

Niro know-how is founded on comprehensive research and development and strengthened through co-operation with dairy organisations and universities.

#### **Product Testing**

Customers from all over the world come to Niro to test new products in our pilot test facilities. Before being launched onto the market, most of our own new developments are tested full-scale at leading dairies.

### *Dairy Data*

APPROX. 600 MILLION  
TONNES OF MILK  
WERE REPORTED  
PRODUCED IN THE  
WORLD IN 2001

# Design for Performance



*From liquid to powder,  
Niro takes products all the way*

#### **Milk**

In milk, Nature has created a unique way of feeding little ones safely and completely. Children need plenty of milk to build bones and teeth, and milk also supplies essential fat and proteins. Finally, milk plays a major role in food for adults with essential vitamins and minerals.

#### **Dried Dairy Products**

Spray drying makes milk widely available, independent of local supplies of fresh milk, and it expands the use of dairy products in food-stuffs. An increased demand for

speciality products with particular features poses new challenges for the plant designer. Whey products in particular are difficult to dry due to their high contents of lactose and minerals, but new techniques, developed by Niro, now enable even these products to be dried with success.

#### **Design for Performance**

Niro is an engineering company specialising in evaporation, spray drying and complementary processes. Every plant is designed carefully to meet individual product specifications. Mechanical execution is always

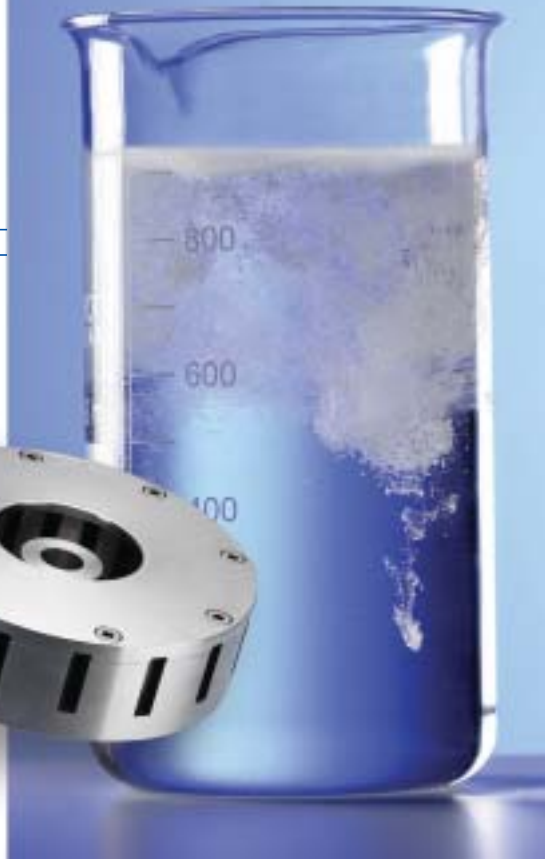
in agreement with official standards, and superior hygiene and safety are integral features of every modern Niro plant.

#### **Durable Relationships**

At Niro, we take pride in keeping good relations with our customers. This is illustrated by the fact that most new business comes from satisfied customers who want to enlarge their production capacity, up-grade plants, or invest in new processes. Niro stays at the forefront of the dairy process business supported by local representatives all over the world.

*Agglomerated milk powder dissolving quickly in cold water*

*Atomizer wheel for milk drying.  
Spherical wheel speed 100-200 m/s*



### **Functionality**

Every day, millions of litres of milk are processed into dry products. By far the largest part ends up as ordinary skim milk and whole milk powders. These products are market commodities with little requirement for product functionality. Consumer demand for specific product properties, particularly in the food industry, has resulted in the development of many different dry dairy products, ranging from instant whole milk powder to speciality food ingredients. Thus the dairy industry invests heavily in the development and production of such products, often in close collaboration with specialists from Niro.

### **Properties**

Milk is unique in its content of valuable nutrients. Both the chemical composition and the physical properties of the milk powder play an important role in its use with quick and complete reconstitution adding convenience to the products.

### **Agglomeration**

Small single particles dissolve instantly in water. Powder consisting of small particles is, however, difficult to disperse. Big particles are easy to disperse in water, but dissolve only partially. Agglomeration optimises quick dispersion of the agglomerates as well as quick and complete dissolution of the small particles forming the agglomerate. Furthermore, agglomeration

# Agglomerated Milk Powders

*The art of achieving perfect product functionality*



**Niro sets the trend in modern process plant design. We meet specific requirements to powder properties, while always keeping plant performance and drying economy in focus.**

*Agglomerated milk powder*



*Dairy Data*

APPROX. 6 MILLION TONNES OF MILK POWDER (SKIM AND WHOLE) WERE REPORTED PRODUCED IN THE WORLD IN 2001

improves the product's flowability and reduces dust problems during powder handling.

Agglomeration is a result of wet and/or semi-dry particle collision. Control is achieved by returning dry fine powder to the wet spray during different stages of spray drying. Mastering the agglomeration techniques is the art of modern spray drying – the art of Niro.

Plant operation and economics are other important parameters. Niro product specialists and plant designers keep those factors in mind when designing spray drying plants to meet our customers' individual needs.

**Agglomerated Whole Milk Powder**

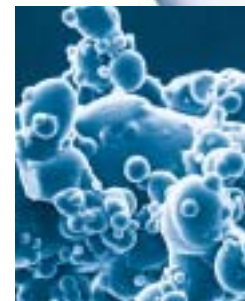
In whole milk powders, some of the fat is present as free fat. Free fat rejects water making it impossible to dissolve these powders properly in cold water.

Homogenization of the whole milk concentrate prior to drying reduces the content of free fat in the final powder. However, to be called 'instant' whole milk powder, it must be agglomerated as well as have a surface-active agent (lecithin) applied to improve water affinity. The product then becomes instant – even in cold water.

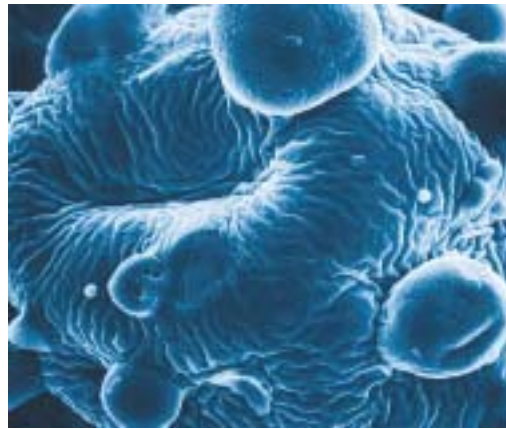
**Agglomerated High Protein Powder**

Powders with high protein content have a very high affinity to water. During rewetting, such powders dissolve so quickly that the particle surface instantly turns into a gel, which prevents further water penetration. The product is left as gel lumps with dry material inside. Agglomeration and a surface-active agent, such as lecithin, can be used to control dissolution speed. And controlling the spray drying process again improves powder functionality.

*Nozzle atomizer with four nozzles and fines return*



*Microphoto (x300) of agglomerated whole milk powder from an MSD™*



*Pressure nozzle.  
Nozzle atomization  
results in good  
powder flowability*



*Complete  
milk powder  
factory*



# Baby Food

*as a reliable alternative*



Every baby food producer has individual recipes and product requirements. Niro adds process and design expertise delivering plants to meet even the strictest demands on product standards.

## Formulations

Infant formulas are developed to be as close to human milk as possible. The digestive system develops as the baby grows older, and baby food formulators must take this into account. Furthermore, most producers have developed products tolerated by hyper-allergic babies. As cow's milk differs in composition from human milk, it is used only as an ingredient in the final

blend along with whey proteins, demineralized whey, maltodextrine, lactose, essential fatty acids, vitamins, and minerals.

## Ingredient Mixing

Baby food products must be blended to the precise composition. The various ingredients come as dry powders, solid fat or liquid oil, and milk concentrate.



*T-profiles used  
for the sanitary  
VIBRO-FLUIDIZER®*



*CIP nozzles in the  
VIBRO-FLUIDIZER® above  
and below air distribution plate*



Baby food production involves several handling procedures such as dissolution, melting, and mixing. The blends need cooling, pasteurization, pre-concentration, and homogenization prior to drying. Integrating each separate process into a continuous process calls for the best expertise on the market – the expertise of Niro.

**Baby Food Drying**

Before drying, the wet mix is pre-concentrated in an evaporator finisher to reduce production costs. The concentrate is then dried in one

of Niro’s special spray dryers, designed to minimize product heat exposure. Since most baby food products are required to be instant, the preferred dryer is typically designed to allow for product agglomeration during drying. All these features add to the quality of the formulated baby food product.

**Meeting Hygienic Standards**

Every Niro plant meets the strictest hygienic standards.

All surfaces in contact with the product are made of stainless steel or other materials accepted and approved by the authorities (FDA). Bends are smooth, surfaces are polished, and hollow spaces and cavities are avoided in the plant design. Finally, the plant is supplied with built-in CIP facilities allowing producers to meet even the strictest hygiene requirements.

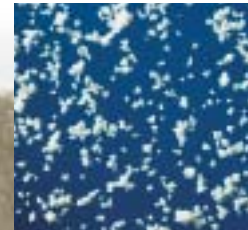
*Dairy Data*

HUMAN MILK HAS ONE OF THE HIGHEST CONTENTS OF LACTOSE (MILK SUGAR), 6.4%. COW’S MILK HAS A LACTOSE CONTENT OF 4.6%





*Whey crystallization tanks*



# Whey

*Valuable nutrients available at low price.*

**Whey is no longer just a problematic by-product of cheese production. It has high value as raw material for a variety of food ingredients – and its importance is still increasing.**

## Origin

Every litre of milk used in cheese production gives an equal amount of whey. Whey composition and quality depend on a wide range of factors including breeding and feeding of the cows, time of year, and the type of bacteria and rennet used in the cheese production. The treatment of the whey from the cheese vats also has a significant influence on the final whey powder quality.

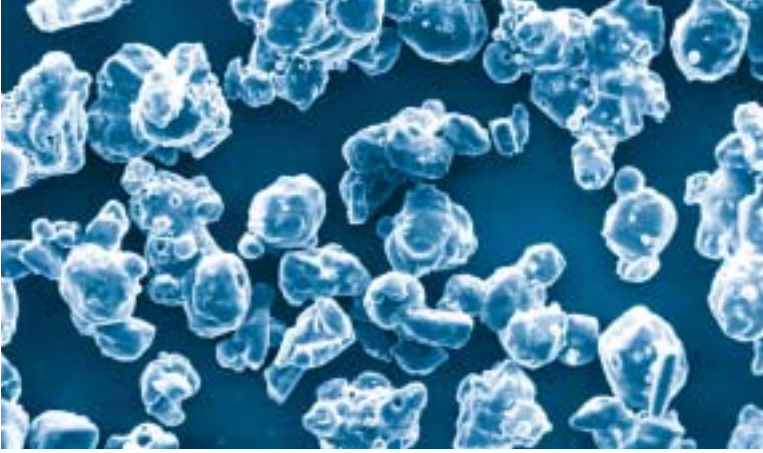
## Whey Treatment

Many smaller cheese producers do not process the whey on site and, therefore, have problems with product deteriora-

tion. The high bacteria load and presence of active enzymes in the raw whey make it extremely important to separate fat and cheese particles, and to pasteurize and cool the whey immediately after removal from the cheese vats. Storage and transport has to be under cooled conditions.

Niro's affiliated companies in the GEA Group offer processes and systems for whey treatment. Niro specialises in membrane filtration, evaporation, and spray drying of whey, and has developed parameters and plant designs to enable optimal economical production while reducing operational problems such as evaporator fouling and powder deposits in the dryer.





*Microphoto (x100)  
of non-caking  
whey powder*

#### *Dairy Data*

140 MILLION TONNES OF  
WHEY IS PRODUCED  
ANNUALLY. ONLY 20% IS  
DRIED, CORRESPONDING  
TO 1.8 MILLION TONNES  
OF POWDER

### **Whey Composition**

Traditionally, whey has been used as an animal feed, but is now becoming increasingly important as raw material in the food industry. Whey powder has an extraordinarily high water and fat binding ability and is, therefore, widely used as filler in food products such as bread, cakes, and delicatessen products. Huge quantities of whey are used by the food industry replacing the more expensive skim milk powder. But whey is much more than just a skim milk replacer. With all the essential amino acids, valuable

minerals and a broad range of other valuable compounds present, whey is today gaining a market as raw material for all kinds of food ingredients.

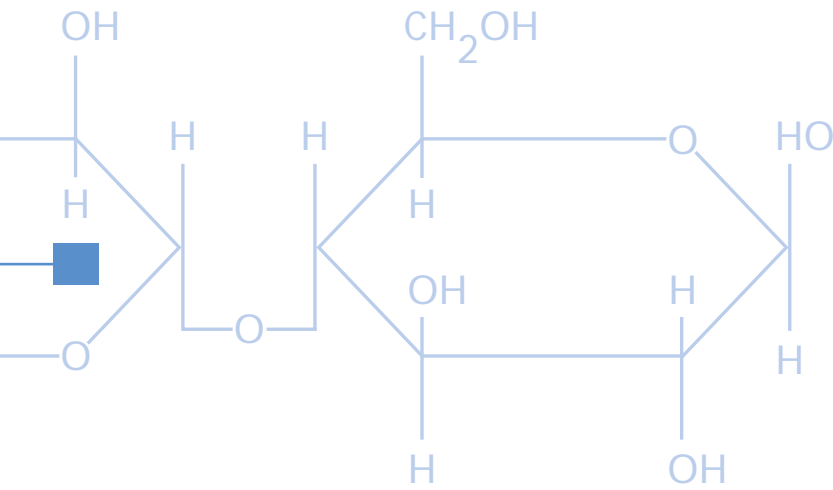
### **Functional Food**

The present trend towards a higher degree of specialisation, including the marketing of functional foods, such as energy drinks, dietary products, and products with a high content of vitamins or minerals, has a great influence on the whey powder market.

In some markets the demand for whey is exceeding the supply, and its proper collection, handling, and processing become increasingly important.

So does the choice of partner for whey processing, which is why most manufacturers go with the best and choose Niro.





*Dairy Data*

WHEY COMPONENTS BASED ON TOTAL SOLIDS:	
LACTOSE	72%
PROTEIN	14%
ASH	10%
FAT	1.5%
LACTIC ACID	2.5%

# Whey Products

*Whey protein concentrate (WPC),  
permeate, and lactose*

With fractionation,  
whey is up-graded,  
adding extra value to  
the dried product.

Whey proteins can be isolated from whey using membrane filtration and subsequent drying in a spray dryer.

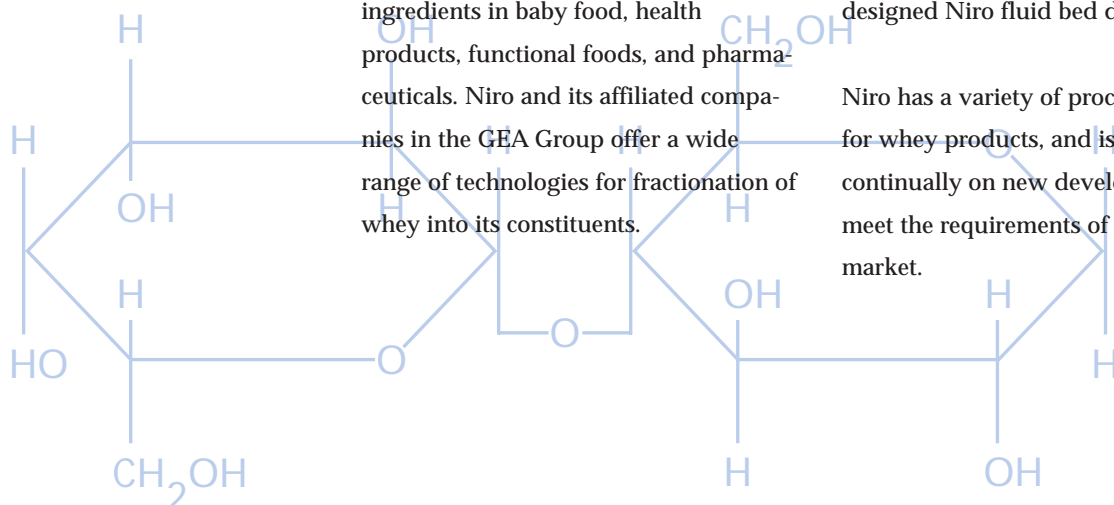
Whey permeate contains lactose and minerals that are difficult to treat in conventional spray dryers. Niro's advanced drying systems, however, overcome these problems.

### One Product – A World of Options

The dry solids in whey are mainly lactose, proteins, and minerals. The different compounds are e.g. used as ingredients in baby food, health products, functional foods, and pharmaceuticals. Niro and its affiliated companies in the GEA Group offer a wide range of technologies for fractionation of whey into its constituents.

Lactose processing involves isolation from permeate by evaporation, crystallization, decanting, further purification, and drying in a specially designed Niro fluid bed dryer.

Niro has a variety of processes adapted for whey products, and is working continually on new developments to meet the requirements of tomorrow's market.





# Coffee Whitener

## *Creamers and cappuccino mixes*

For creamer products to be convenient in use, they must meet a wide range of requirements. In addition to having a creamy taste and character, the products must be agglomerated and instant – demands met to precision by Niro spray drying technology.

### **Growing Market**

Large quantities of coffee creamers are produced for use with dried coffee. These are marketed direct or mixed with dried coffee and sugar into a great variety of ready-to-drink mixes. All over the world creamers are used for convenience, particularly in working environments. And with the development of processes for foaming creamers, the market for cappuccino mixes for use at home has grown considerably.

### **Designed for Convenience**

Although coffee creamers are non-dairy in origin, they share many characteristics with dairy products, being high in fat and carbohydrate content and quite difficult to dry in a conventional processing plant. The Niro MSD™ is a spray dryer and an agglomerator in one unit. This dryer is particularly suited for drying high fat and carbohydrate-containing products and making them convenient to use.



*Multi-distribution system on top of calandria*



# Liquid Treatment and Concentration

*The more water removed upstream of the dryer, the better the plant economy*

As a member of the GEA Group of companies Niro has direct access to state-of-the-art liquid processing engineered by Tuchenhagen, Westfalia Separator, and GEA Filtration.

## Integral Parts of the Process

Liquid processing includes reception, cooling, storage, separation, pasteurization, and evaporation. These processes are all integral parts of the Niro dairy solutions.

The different membrane techniques, such as reverse osmosis, micro- and ultrafiltration, remove water and isolate certain substances. Membrane processes are essential in the fractionation of e.g. whey, and ultrafiltration in particular is a precondition for the production of a range of speciality products such as WPC. GEA Filtration masters those technologies and provides the full range of membrane filtration systems.



*Falling film evaporator with thermal vapour recompression (TVR)*



*Falling film evaporator with mechanical vapour recompression (MVR)*

*Dairy Data*

AN EVAPORATOR SUPPLYING  
CONCENTRATE FOR A  
15 TONNES PER HOUR SPRAY  
DRYER CONTAINS UP TO  
100,000 METRES OF TUBES.  
APPROX. 150,000 COWS ARE  
NEEDED TO KEEP THE PLANT  
RUNNING CONTINUOUSLY



**Evaporation**

Removing water in a spray dryer is more costly and requires more energy than in an evaporator. In addition to membrane filtration, Niro offers a variety of evaporator designs for pre-concentration of all the different dairy products.

Niro dairy evaporators are typically multi-stage types with either mechanical or thermal vapour recompression. The evaporators are with built-in pre-

heaters, pasteurizers, and flash coolers depending on the application. In addition, Niro has designed special direct steam injection pasteurizers with regenerative systems for minimum steam consumption. The units also provide the possibility of making tailor-made heat classified powders. The Niro flash cooler gives an instant temperature drop before the crystallization of whey concentrate to provide small crystals and efficient crystallization.

**Homogenization**

Whole milk and other products with high fat content need homogenization prior to drying. Niro Soavi has developed a range of high-pressure pumps and homogenizers, which are used for all fat containing products. Homogenization under high pressure turns fat globules into microscopic size, optimal for digestion, and allows the production of dried powder with a low free fat content. Niro Soavi homogenizers are recognised worldwide for their performance and stability.



*Ultrafiltration plant for whey*



*Tangential swirl heater for direct steam injection*



*Five piston high pressure pump for homogenization*



*Pressure nozzle  
atomizer in operation*



*Rotating atomizer  
wheel in operation*

# Spray Drying

## *The heart of the milk powder factory*

Since Niro's founder in the 1930's applied for patents on rotary atomizers and launched the new technology to the dairy industry, Niro has been at the forefront of spray drying.

Niro has maintained the position as a world leader in evaporation and spray drying technology and is working continually on new ideas, improvements of equipment, and optimisation of plant design. Still stricter demands to e.g. product specifications, hygiene, plant safety, and environmental protection pose new challenges to be met by our plant designers.

### **Tailor-Made Spray Dryers**

Niro offers a great variety of spray dryer designs, every one with its own particular features. The first priority when selecting the dryer design is given to the product – its chemical composition and the required physical structure, the preferences of the operator, and the limitations given by the location of the plant. Every Niro spray drying plant is designed to meet every criterion and ensure customer satisfaction.



### *Dairy Data*

BY ATOMIZING 1 LITRE  
OF CONCENTRATE, YOU  
OBTAIN  $1.5 \times 10^{10}$   
PARTICLES WITH A  
DIAMETER OF  $50 \mu$   
AND A TOTAL SURFACE  
AREA OF  $120 \text{ m}^2$