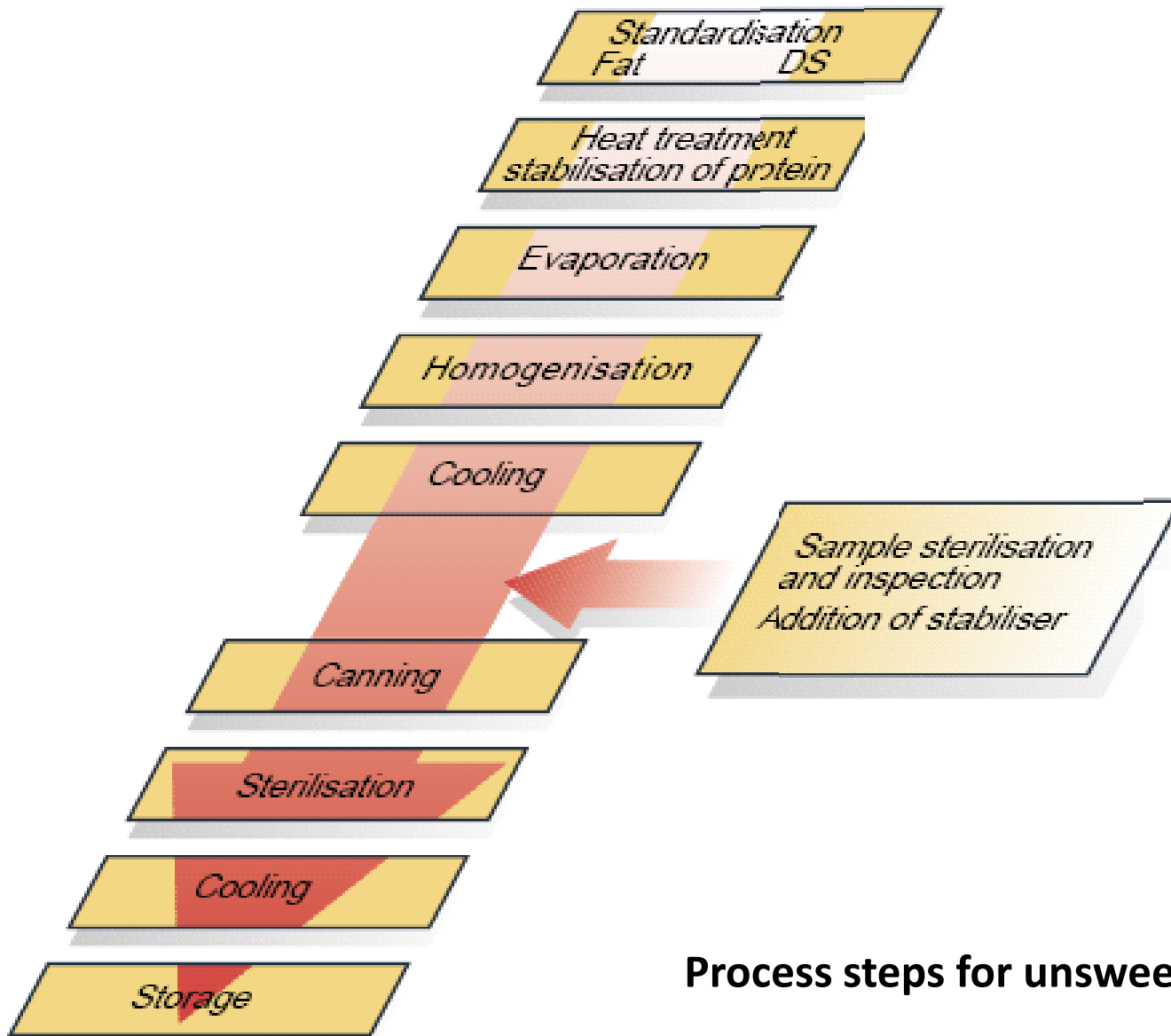
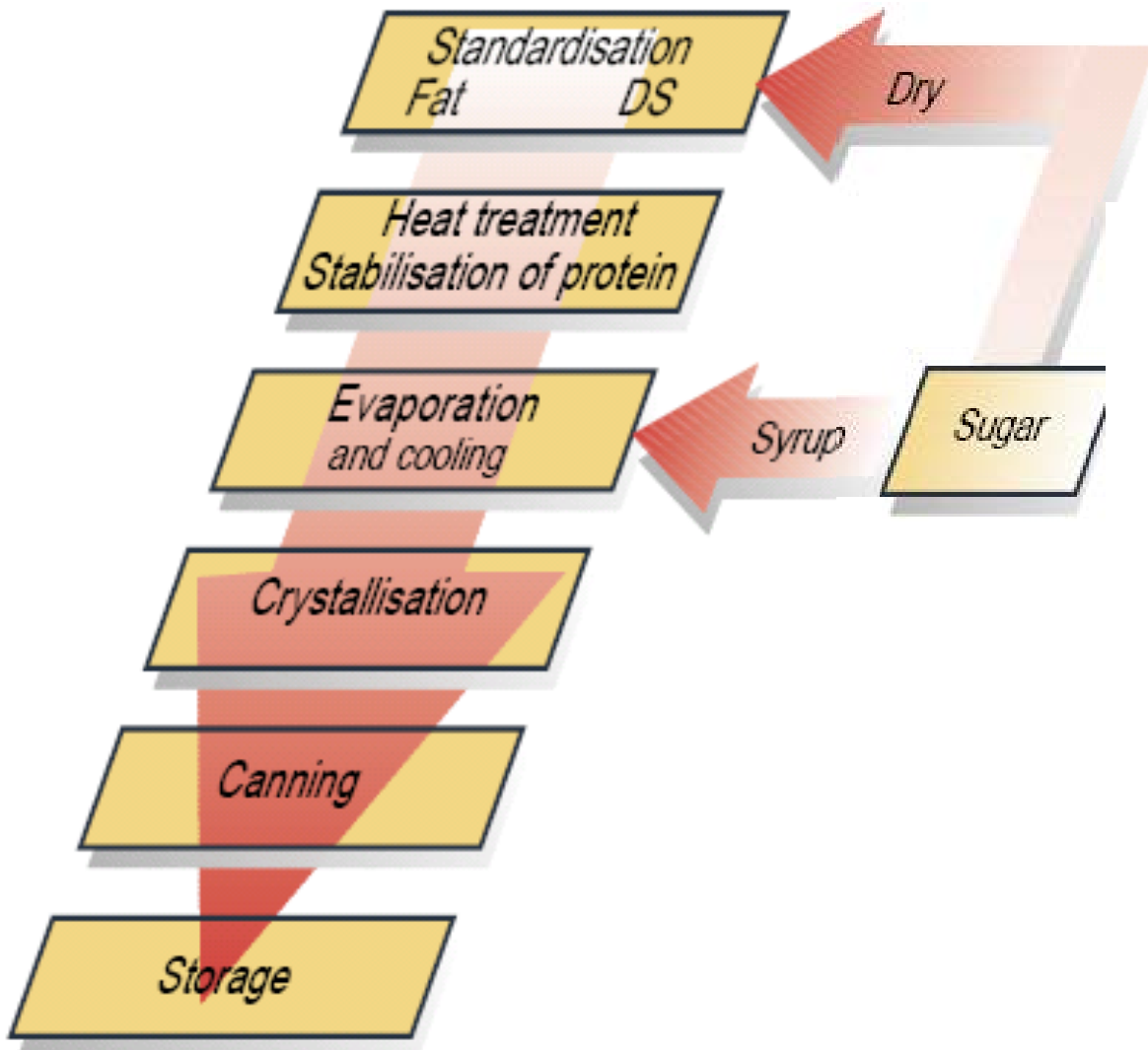


# صنایع لبنی 2

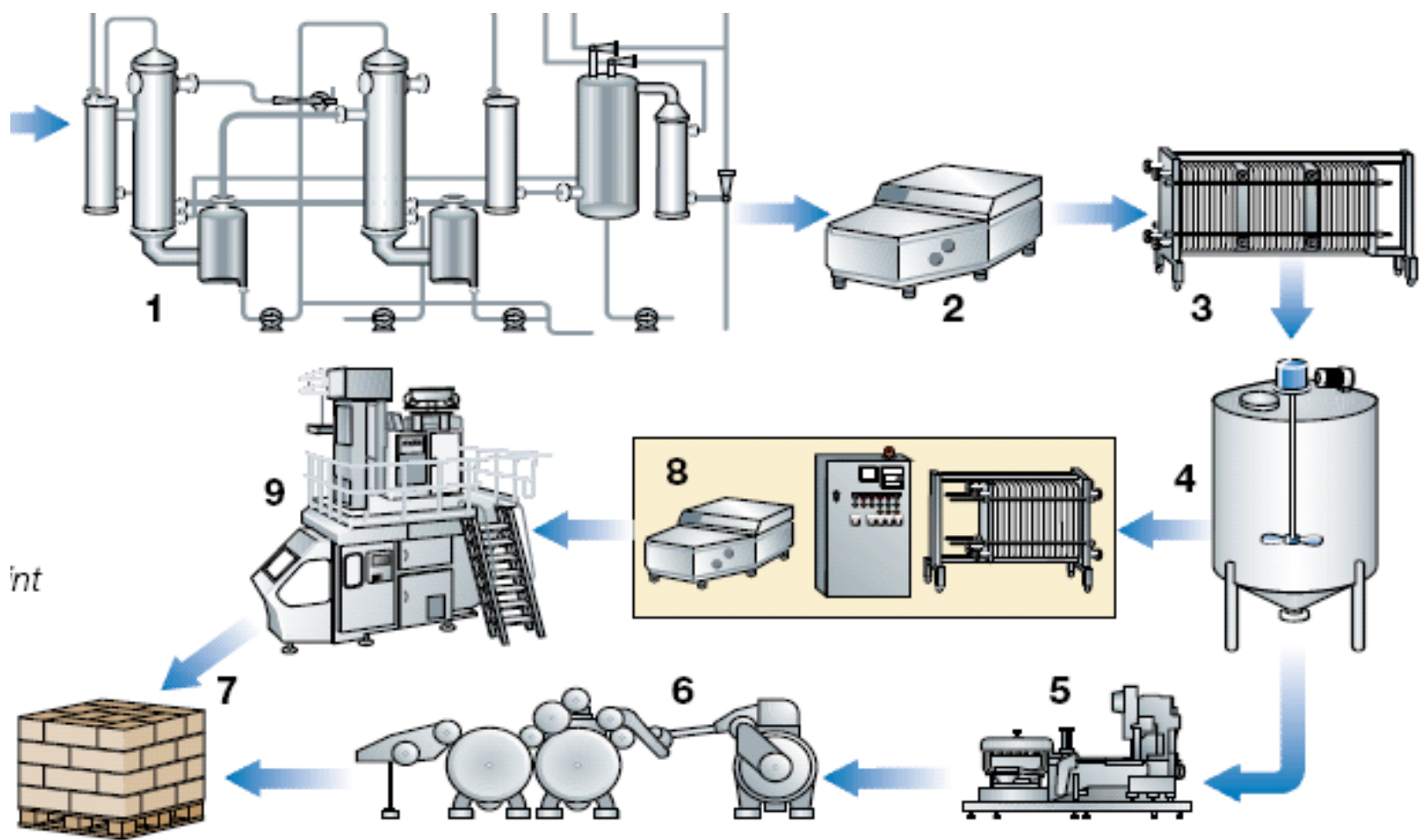
دکتر علی نصیرپور



**Process steps for unsweetened condensed milk**

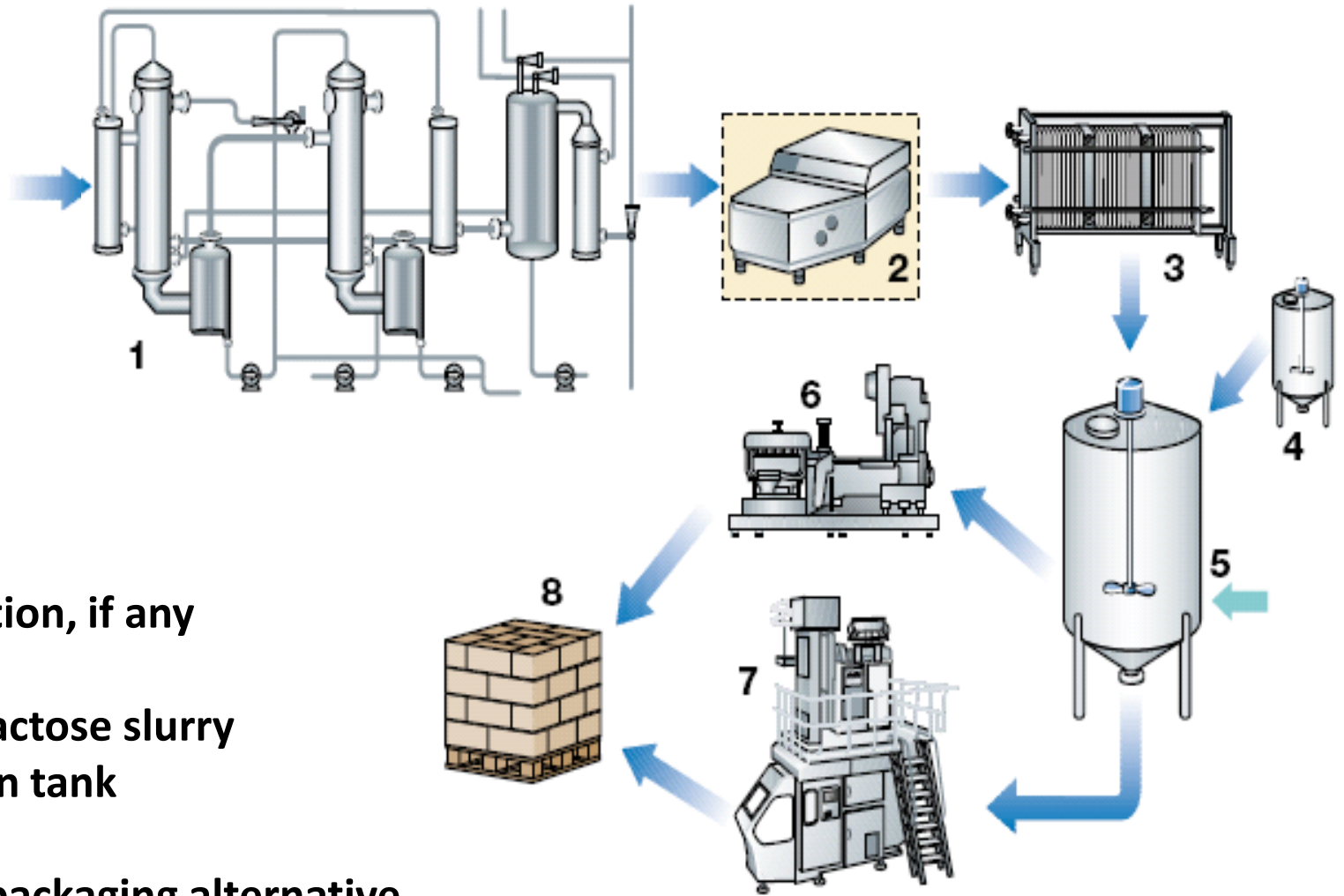


**Process steps for sweetened condensed milk**



## Process line for unsweetened condensed milk

- 1 Evaporation, 2 Homogenisation, 3 Cooling, 4 Intermediate tank  
 5 Canning, 6 Sterilisation, 7 Storage Alternative processing to point 5 and 6  
 8 UHT treatment, 9 Aseptic filling



- 1 Evaporation
- 2 Homogenisation, if any
- 3 Cooling
- 4 Addition of lactose slurry
- 5 Crystallisation tank
- 6 Canning
- 7 Paperboard packaging alternative
- 8 Storage

## Process line for sweetened condensed milk



***Milk powder***

## *Extra grade skim milk powder*

(ADMI\* specification for skimmed milk powder)

<b>Property</b>	<b>Spray dried not exceeding</b>	<b>Roller dried not exceeding</b>
Milk fat content	1.25 %	1.25 %
Moisture content	4.00 %	4.00 %
Titratable acidity, l.a.	0.15 %	0.15 %
Solubility index	1.25 ml **	15.00 ml
Bacterial estimate	50 000 per gram	50 000 per gram
Scorched particles	Disc B (15.0 mg)	Disc C (22.5 mg)

\* ADMI = American Dry Milk Institute Inc. (This institution has also published "Standards For Grades of Dry Milks including Methods of Analysis").

\*\* Except powders designated as "high-heat" (HH), for which the permitted maximum is 2.0 ml.

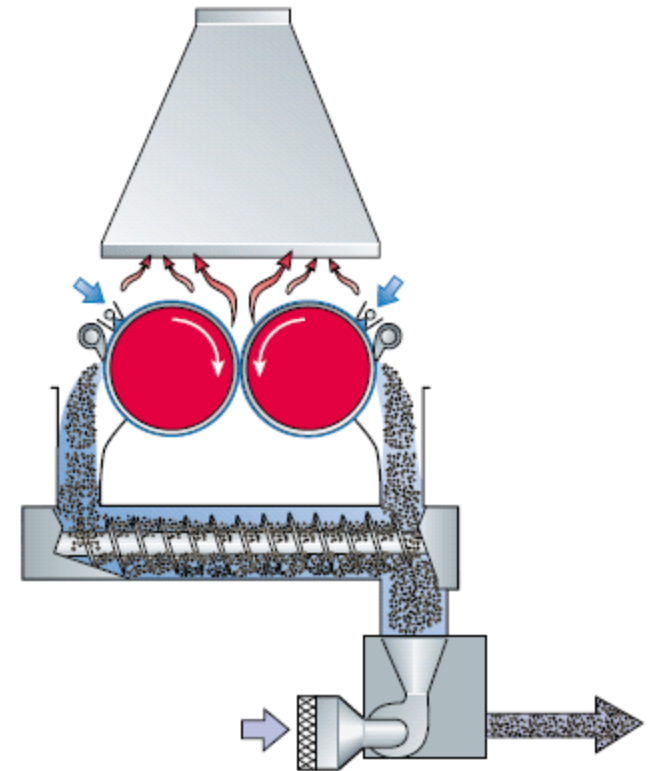
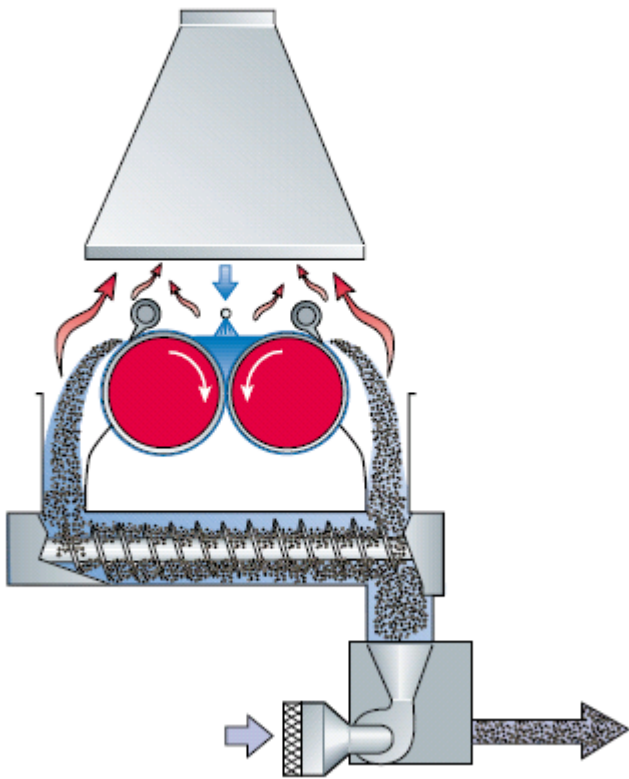
## Categories of spray dried skimmilk powder.

Category	Temp/time	WPNI mg/g u.w-p
Extra low-heat	<70°C	*
Low-heat (LH) powder	70°C/15 s	> 6.0
Medium-heat (MH) powder	85°C/20 s	5 – 6.0
"	90°C/30 s	4 – 5.0
"	95°C/30 s	3 – 4.0
Medium high-heat (HH)	124°C/30 s	1.5 – 2.0
High-heat (HH)	appr. 135°C/30 s	<1.4
High-heat high stable (HHHS) (from selected milk)	appr. 135°C/30 s	<1.4

\* Not measurable

Table by Sanderson N.Z., *J. Dairy Technology*, 2, 35 (1967)



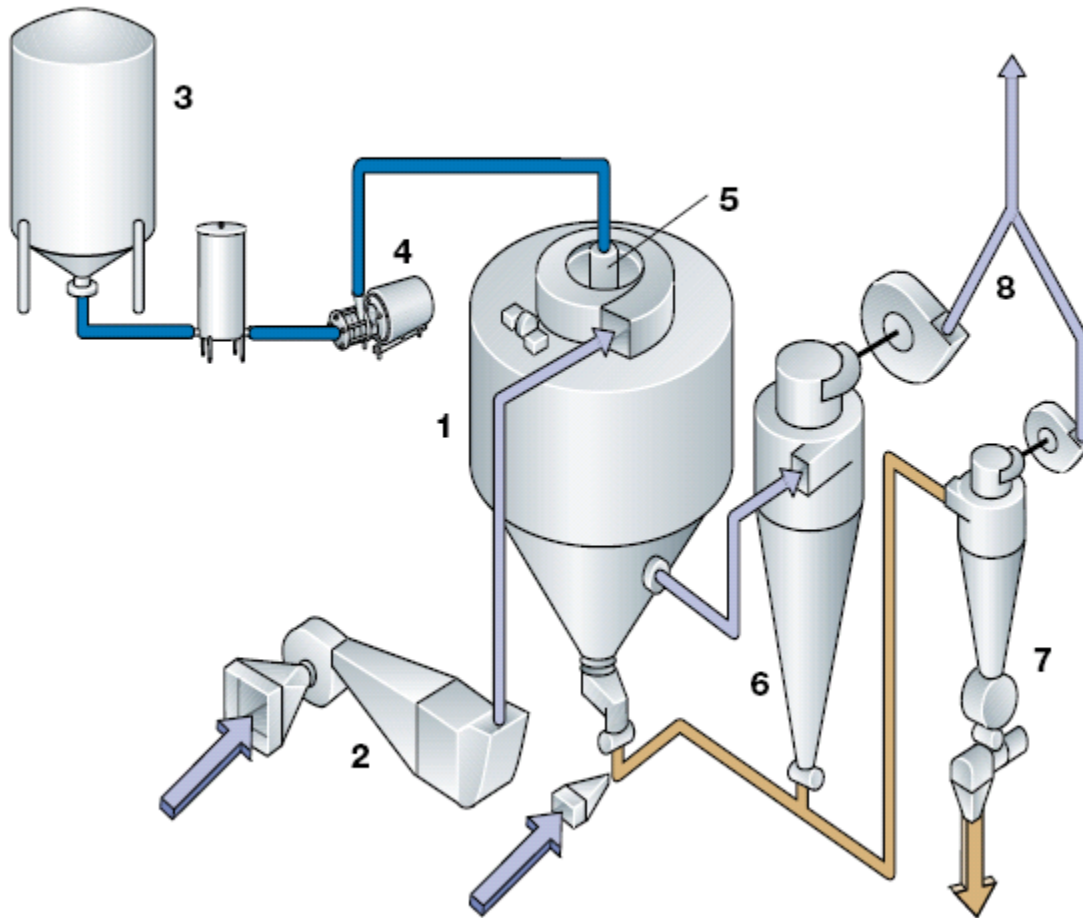


**Principle of the trough-fed roller dryer**

**Principle of the spray-fed roller dryer**

*Milk*  
 *Heating medium*  
 *Air for pneumatic transportation and cooling*

*Milk*  
 *Heating medium*  
 *Air for pneumatic transportation and cooling*

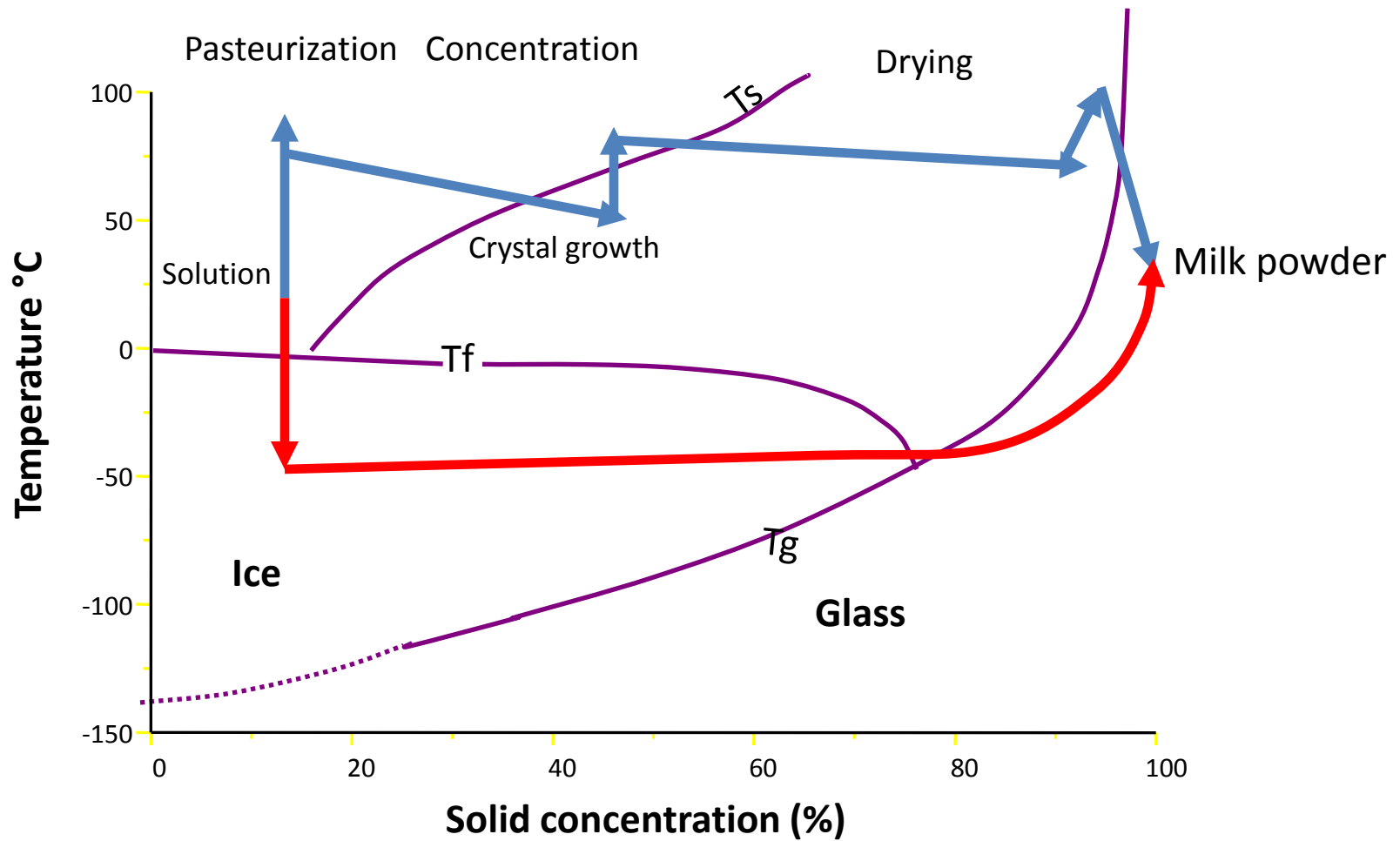


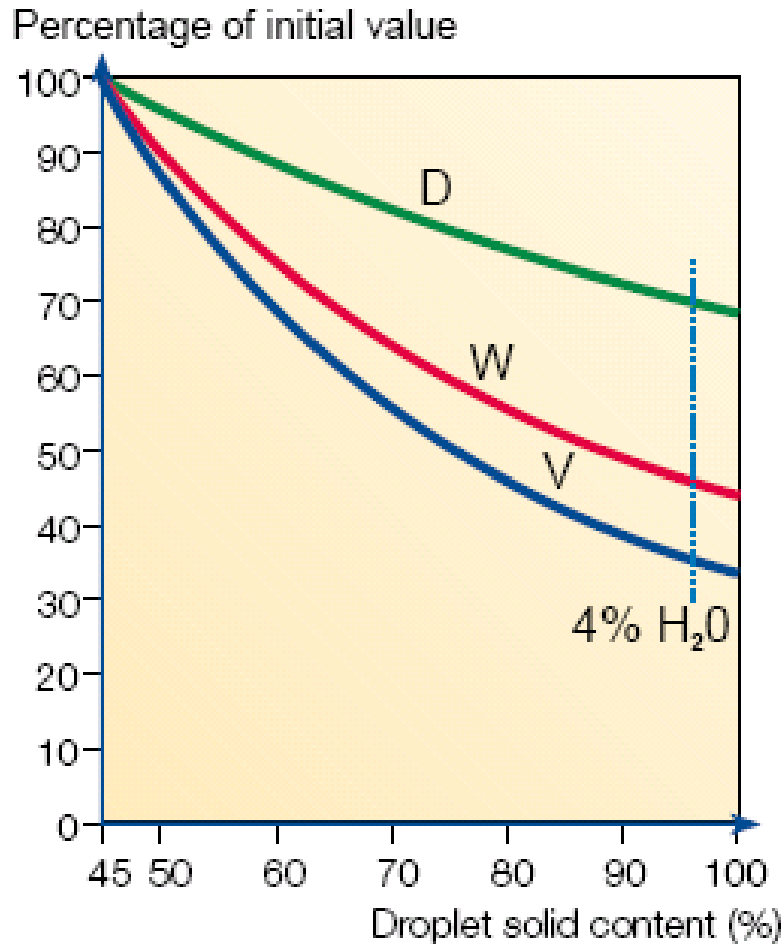
**Conventional spray dryer  
(one-stage drying) with conical  
base chamber.**

- 1 Drying chamber**
- 2 Air heater**
- 3 Milk concentrate tank**
- 4 High pressure pump**
- 5 Atomiser**
- 6 Main cyclone**
- 7 Transport system cyclone**
- 8 Air suction fans and filters**



# Phase changes during drying



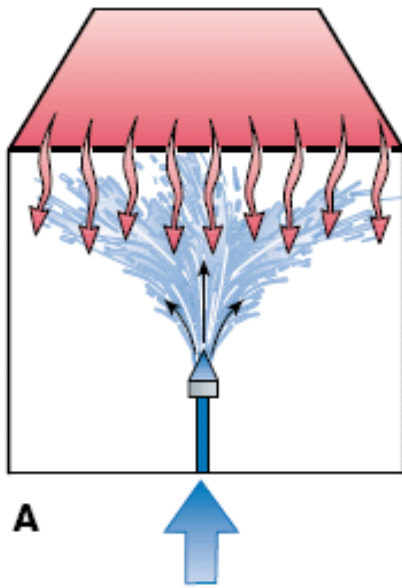


**Weight, volume and diameter decrease of droplet under ideal drying conditions down to 4% H<sub>2</sub>O.**

**D = Diameter**

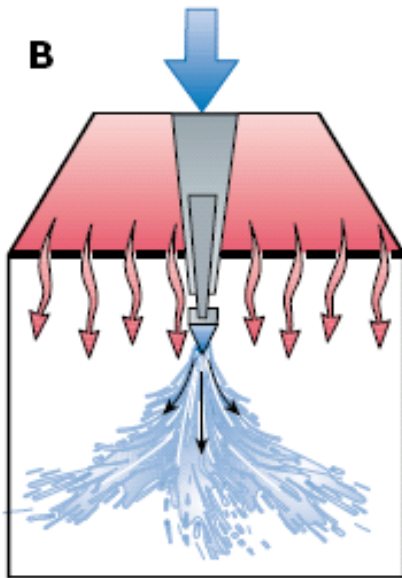
**W = Weight**

**V = Volume**

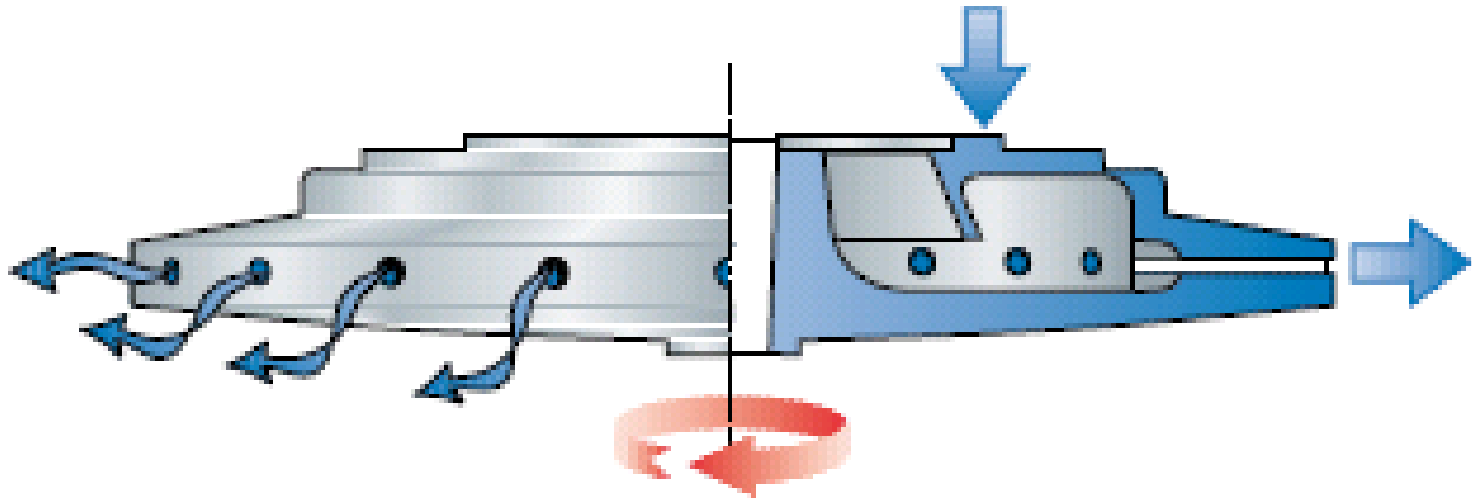


**Stationary nozzles for atomising the milk in a spray drying chamber.**

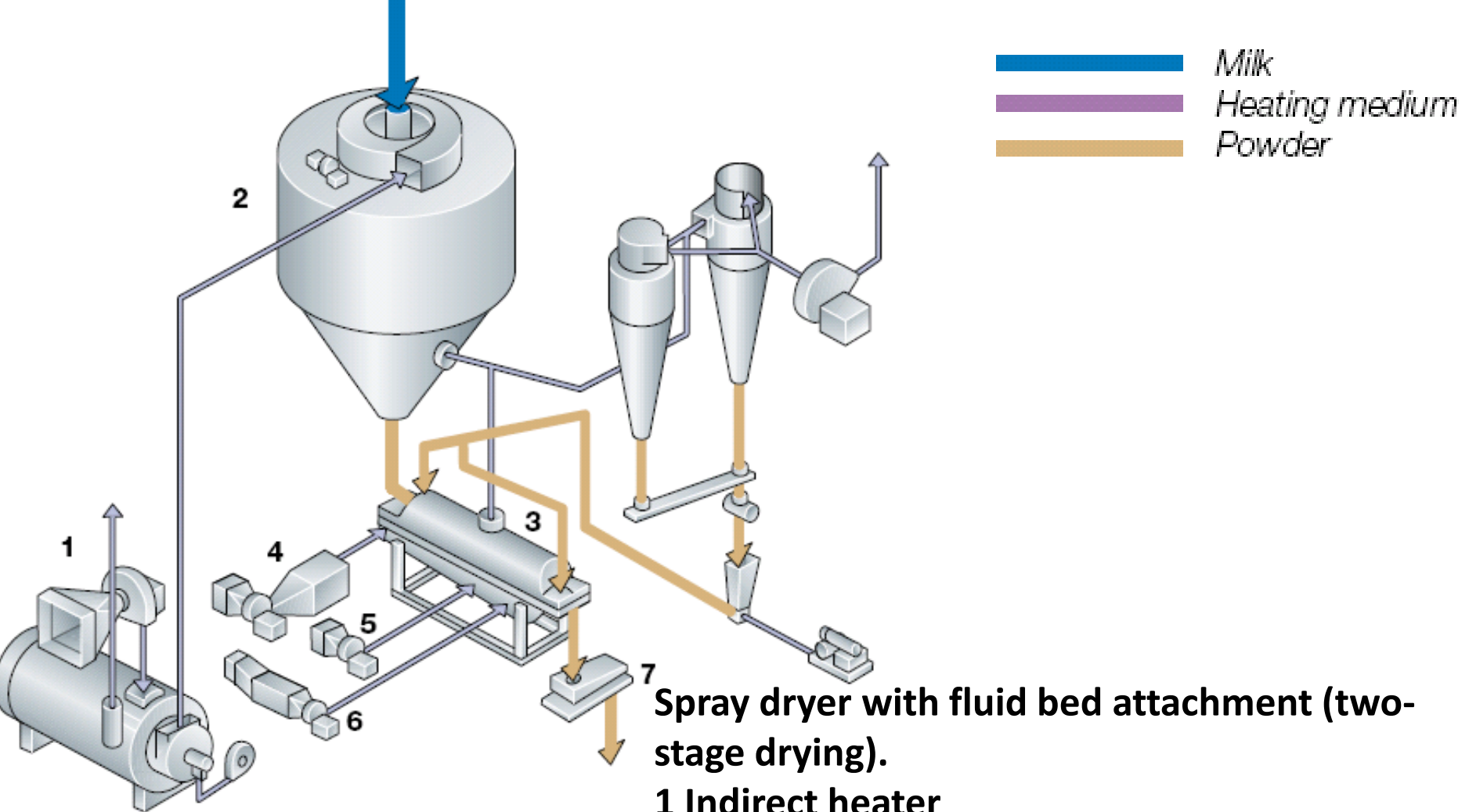
**A Counterflow nozzle**



**B Nozzle discharging in the direction of the air flow**



**Rotating disc for atomising milk in the spray drying chamber**



**Spray dryer with fluid bed attachment (two-stage drying).**

- 1 Indirect heater**
- 2 Drying chamber**
- 3 Vibrating fluid bed**
- 4 Heater for fluid bed air**
- 5 Ambient cooling air for fluid bed**
- 6 Dehumidified cooling air for fluid bed**
- 7 Sieve**

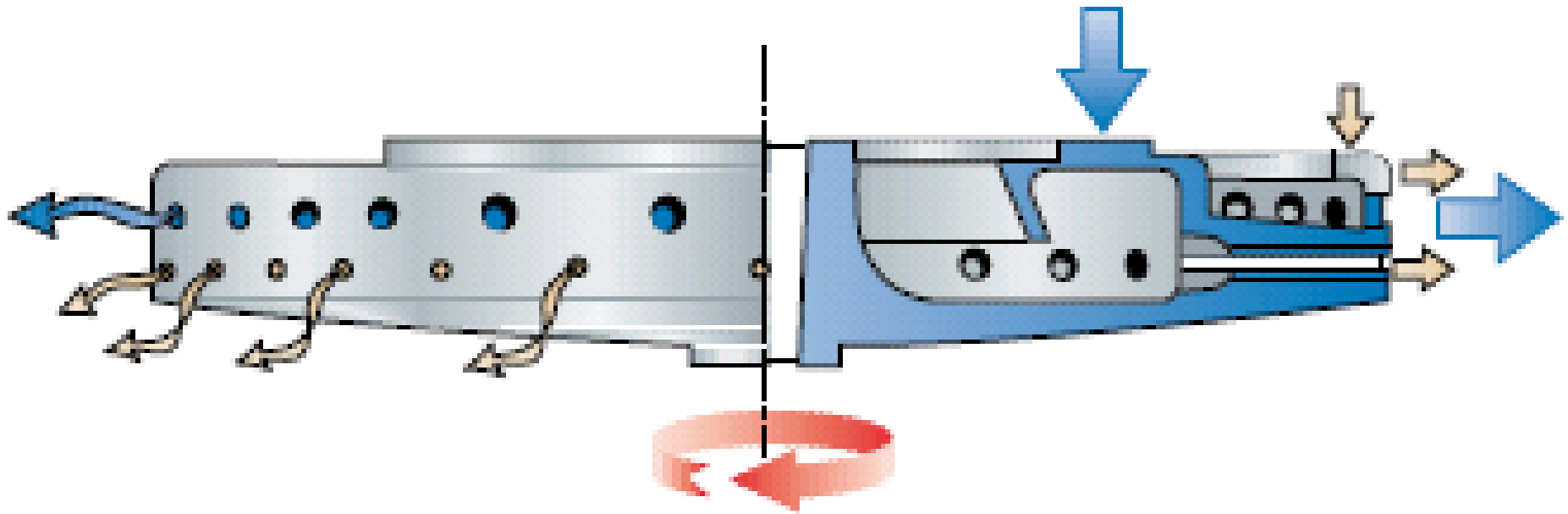
## Comparison of one-stage and two-stage drying systems.

Drying system	One-stage Inlet temp. 200°C	Two-stage Inlet temp. 200°C	Inlet temp. 230°C
<i>Spray dryer (First stage)</i>			
Evaporation in chamber, kg/h	1 150	1 400	1 720
Powder from chamber:			
6 % moisture, kg/h	–	1 460	1 790
3.5% moisture, kg/h	1 140	–	–
Energy consumption,			
spray drying total, Mcal	1 818	1 823	2 120
Energy/kg powder, kcal	1 595	1 250	1 184
<i>Fluid Bed (Second Stage)</i>			
Drying air, kg/h	–	3 430	4 290
Inlet air temperature, °C	–	100	100
Evaporation in fluid bed, kg/h	–	40	45
Powder from fluid bed			
3.5 % moisture, kg/h	–	1 420	1 745
Energy consumption, kW	–	20	22
Energy consumption,			
total in fluid bed, Mcal	–	95	115
<i>Total plant</i>			
Energy consump. total, Mcal	1 818	1 918	2 235
Energy/kg powder total, kcal	1 595	1 350	1 280
Energy relation	100	85	80

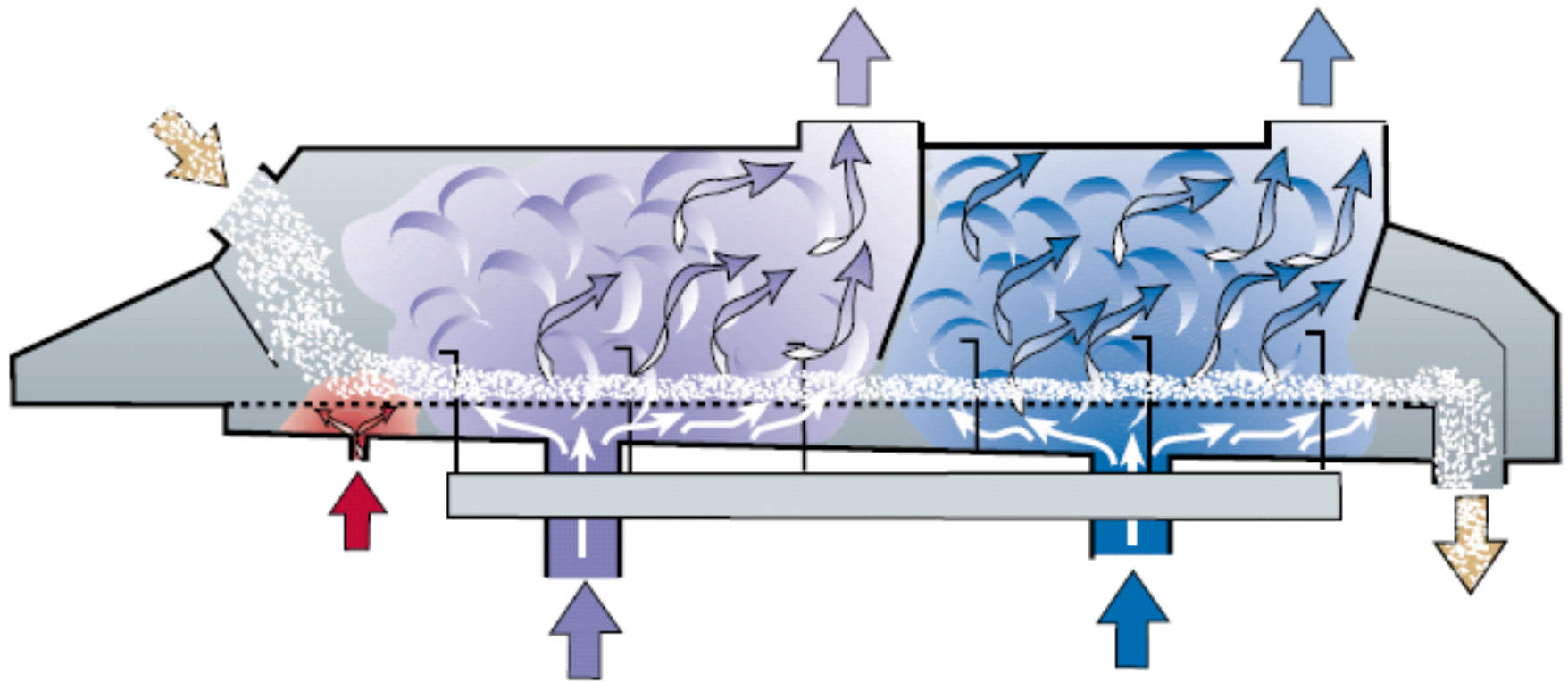
Basis: Same drying chamber size with inlet air flow = 31,500 kg/h.  
Product: skimmilk, 48% solids in concentrate.

Source: *Evaporation, Membrane Filtration, Spray Drying - North European Dairy Journal, 1985 Copenhagen, Denmark.*  
ISBN No. 87-7477-000-4.





**Rotating disc designed for production of instantised powder**



**Fluid bed for instantising milk powder**

-  Milk powder
-  Steam
-  Hot air
-  Cold air