堃霖空調
KUENLING A/C

真空凍結乾燥設備
Vacuum Freeze-Drying Equipments

ISO 9001 SGS
OHSAS 18001 SGS

真空凍結乾燥簡介
(Introduction of Vacuum Freeze-Drying)

凡農產品均有其季節性、地區性、不易儲存性及運輸等之困難。諸多缺點，可以用冷凍脫水方式處理，俟須使用時再加水復原，恢復原狀原味，真空凍結乾燥方式最為理想。

真空凍結乾燥法就是將含有大量水分的產品急速凍結成為固體，置於密閉倉內抽真空，將水分由固體狀的冰直接昇華為水蒸氣，再用冷凍設備捕捉水份，直到產品釋出95~98%以上的含水份，而產品本身則留在凍結時的冰架中，因此在乾燥後體積不變，疏鬆多孔，可完善的保存食物的新鮮度及營養成分，因而提高產品的附加價值。

本公司之真空凍結乾燥機設備採用進口低溫壓縮機來運轉冷凍循環系統，再配合進口真空泵及冷熱媒循環使用。本公司機組操作簡便，所製作產品，品質均勻，復原性良好。

Almost all farm products have seasonable, local, hard store and transport problems, but those disadvantages may well solve by freeze-drying process. Those products may add water to recover their shape and flavour when they will be use. The vacuum freeze-drying is the best ideal drying process.

Vacuum freeze-drying is a developed method, by which the product of containing water is quick frozen at low-temperature state and the chamber is evacuated became a vacuum, then the ice sublimes and directly turns vapor to condense and discharge by refrigerating unit until water content reduce 95~98%, but product will still on the plate tray. Therefore the product maintained constant volume and turned into lacunose and floppy after drying, and will kept fresh and nutrition preferably to improve its additional value.

Our vacuum freezing-drying units adopt imported low-temperature compressors to run circulating refrigeration system and cooperate with imported vacuum pumps and circular cool/hot mediums in drying process. Our units are easy operating and their products will keep uniform quality and easy reconvert.


青　藻
green algae


青　豆
string bean


納　豆
natto


納豆粉
natto powder


橘　子
tangerine


鳳　梨
pineapple


奇異果
kiwi


香　蕉
banana


蛋　黃
yolk


蛋黃粉
custard powder


神秘果粉
mysterious fruit powder


紅麴麴菌
Monascus purpureus


羊乳酸菌
lactobacillus of goat milk


大豆異黃銅
Isoflavone


蜂　蛹
apian pupa


雄蜂蛹
drone pupa


鯊魚軟骨
shark cartilage


牛蒡
burdock


榴　槤
durian


蘋　果
apple


鳳　梨
pineapple


大　蒜
garlic


桑葚粉
mulberry powder

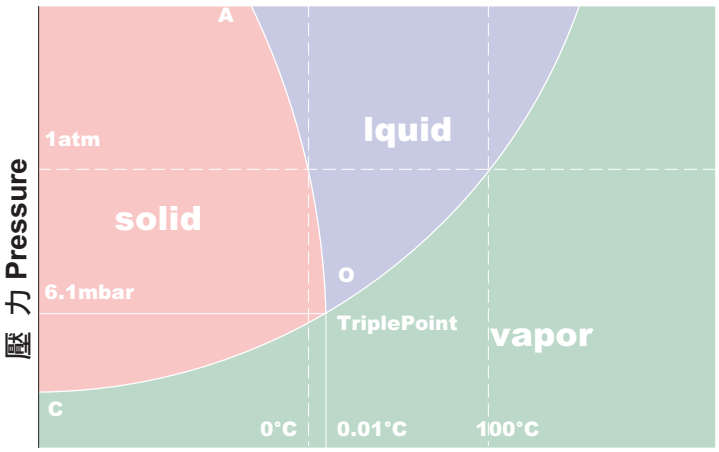

蛋清粉
albumen powder

真空凍結乾燥原理
(Principle of Vacuum Freeze-Drying)

真空凍結乾燥是先將濕物料在共晶點（三相點）溫度以下凍結，使水分變成固態的冰，然後在適當的真空度下，使冰直接昇華為水蒸汽，再用真空系統中的冷凝器將水蒸汽冷凝，從而獲得乾燥製品的技術。

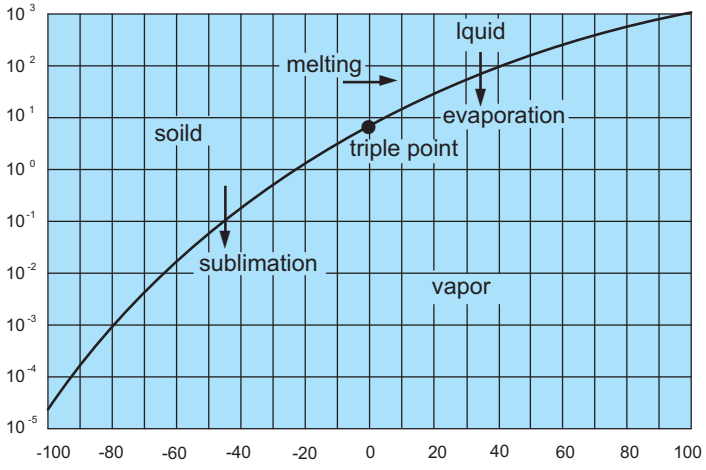
1.基礎概念—昇華

從水的相位圖(參考下面汽壓曲線圖)就可以簡潔有力的解釋壓力與昇華的相關原理，此也就是真空凍結乾燥之主要工作原理－將冰直接昇華為水蒸汽。水相圖中OA、OB、OC三條曲線分別表示冰－水、水－水蒸氣、冰－水蒸氣兩相共存時水蒸汽與溫度之間的關係，分別稱為融化曲線、汽化曲線和昇華曲線。O點稱為三相點，所對應的溫度為0.01℃，水蒸氣壓為6.11mbar（4.58mmHg，611Pa），在這樣的溫度和水蒸氣壓下，水、冰、水蒸氣三者可共存且相互平衡。當溫度或壓力變化，就會發生一相到另一相的突變。冷凍到固態的水溶液改變溫度或壓力就會發生由固態到氣態的相變-昇華。在高真空狀態下，利用昇華原理，使預先凍結的物料中的水份，不經過冰的融化，直接以冰態昇華為水蒸汽被除去，從而達到冷凍乾燥的目的。因此，真空冷凍乾燥又被稱為昇華乾燥。從理論上說，真空冷凍乾燥的操作區域只需在水的三相點以下即可。但實際的操作條件要苛刻得多，通常在0.5~1.5mbar的真空度和-25℃左右溫度下，才能保證冷凍的順利進行。



溫 度 Temperature

水的相圖(the phase diagram of water)



水與冰的蒸氣壓曲線

Vapor pressure curve for ice and water, 1mbar=10^2 Pa

2. 真空凍結乾燥過程步驟：

a. 預凍：為接下來的昇華過程準備樣品，將產品凍到凝固點以下10~20℃。
b. 乾燥：在此過程中，冰昇華而不融化。
c. 加熱後乾燥，在此過程中，鍵和於固體物質的殘留水分被除去，從而留下乾燥樣品，這一步驟對儲存樣品的穩定性非常重要。

（自然法則：產品之溫度控制取決於真空度。）

真空凍結乾燥原理
(Principle of Vacuum Freeze-Drying)

真空乾燥設備(1)
Vacuum Freeze-Drying Unit (1)

真空乾燥設備(2)
Vacuum Freeze-Drying Unit (2)

Vacuum freeze-drying is a kind of technology to obtain the dry products. The wet-product ot containing water is quick frozen under triple-point temperature state firstly，and make the moisture turns into the ice of the solid state, and then the ice will sublimes and directly turns vapor under the proper vacuity. The vapor will be condensed into water to drain by condenser and the product becomes dried finally.

1.Basic concept of Vacuum Freeze-Drying—Sublimation

The principle of sublimation is briefly explained using the phase diagram of water (freeze drying of mainly aqueous solutions, see vapor pressure curve). In the phase diagram of water, the OA, OB, and OC called vaporization line, fusion line, Sublimation line. At any point on the curves, the temperature and pressure allow two phases to exist in equilibrium: solid and liquid, solid and vapor, or liquid and vapor. If the atmospheric pressure is higher than 6.11 mbar, water passes through all three phases (solid, liquid, gas) when the temperature is lowered or raised. At 6.11 mbar the melting pressure curve, vapor pressure curve and sublimation pressure curve meet in one point called triple point(0.01℃). At this point, all three phases occur in parallel (simultaneously). Below this point, i.e. when the pressure is lower than 6.11 mbar, the ice is converted directly from a solid to a gaseous phase on reaching the sublimation pressure curve (vapor pressure curve above ice). In theory, the operation of the Vacuum Freeze-Drying is only needed under the point. But the real operation condition is much more harsh, Usually in the vacuity of 0.5~1.5mbar and under the temperature between about -25℃ could guarantee the harmony of the Vacuum Freeze-Drying.

2.The process steps of freeze drying

(1) Pre-Freezing： The products are frozen to 10~20℃ under solidifying point.

(2) Drying： Keeps the water contents in ice phase under vacuum (e.g. at 0.01mbar).

(3) Additionally necessary energy input (= heating)： The material remains in the soild/ice phase.
(Physical law：the vacuum is responsible for the product temperature.)

凍結乾燥比較與應用
(Application and Comparison of Freeze-Drying)

1.比　較：

(1)優點：

(A)原料之型態、顏色、營養、芳香、成份及味道只有些許變化。

(B)產品無污染、殘留水分少(1~3%)，含菌數低、保存性良好，常溫運送方便。

(C)產品組織不變，粉碎溶解容易，復原性好！

(2)缺點：

(A)設備費用高，冷凍設備難操作低於-60℃，真空泵性能要求高。

(B)產品吸濕性高，需密閉包裝，易碎需注意包裝。

2.應　用：

(1)蔬菜類：洋菇、紅蘿蔔、甜玉米、菠菜、芹菜、青豆仁、高麗菜、香菇絲、紅辣椒、青蔥、大蒜、木耳、香菜、綠蘆筍。

(2)肉類：牛肉片、豬肉片、雞肉、鴨肉。

(3)海鮮類：蝦仁、魷魚、吻仔魚、蟹肉、干貝絲。

(4)調理類：豆腐、味噌湯、醬油粉、醋粉、茶精、咖啡精。

(5)健康食品：蜂王漿（乳）、花粉、魚骨膠、蒜頭精、茶精、靈芝精、香菇精、酵素、抗生素。

(6)冰品水果粉：草莓粉、香蕉粉、鳳梨粉、奇異果等。

(7)其它：微生物（各種細菌）、酵母、醫學血清血漿、生物學與生體學標本、藥類抗生素。

1.Compare：

(1)Advantages：

(A)The shape, color, nutrition, flavour, element and taste of ingredients are only a little transition.

(B)Products had no vitiations, kept little residual water content (1~3%) and low bacteria number, and easy storage and transport under normal temperature.

(C)The substances of products kept uniform and they were easy comminuting to deliquesce and reconvert.

(2)Disadvantages：

(A)The cost of facilities is high and the refrigerating unit is difficult to operating under minus 60℃, and the required performance of vacuum pump is high.

(B)The hygroscopic and brittle order of product is high, so the airtight and careful packing is necessary.

2.Application：

(1)Vegetable: mushroom, carrot, sweet corn, spinach, celery, kernel of string bean, cabbage, shredded shiitakes, red pepper, green onion, garlic, wood ear, caraway, green asparagus.

(2)Meat: beefsteak, pork slices, chicken, duck

(3)Seafood: shrimp meat, squid, little silver fish, crabmeat, shredded scallop.

(4)Cook food: bean curd, miso soup, sauce powder, vinegar powder, tea concentrate, coffee concentrate.

(5)Health care food: royal jelly (bee milk), pollen, fishbone glue, garlic extract, tea extract, extract of glossy ganoderma, shiitakes extract, enzyme, antibiotics.

(6)Ice & fruit power: strawberry powder, banana power, pineapple power, kiwi fruit…etc.

(7)Others: microbe (various germ), yeast, medical serum & blood plasma, specimens of biology & somatology, physic antibiotics.

真空乾燥機規格表
(Specifications Table of Vacuum Freeze-Drying Units)

機型(model) / 項目(item)	單位 (unit)	KLCV-10	KLCV-50	KLCV-100	KLCV-200
乾燥倉(drying chamber)	mm	650Φ×1000L	1050Φ×1200L	1250Φ×1450L	1450Φ×1750L
材質(material)		SUS 304	SS400	SS400	SS400
倉門(cover of chamber)		前門旋轉式 (screw front cover)			
乾燥棚面積 (shelf area)	m^2	1.2	4.9	10.1	18.5
固定的有效層 (fixed effective layers)		3	8	12	13
間隔(shelf spacing)	mm	100	75	75	75
置物盤(plate tray)	mm	$390^W \times 770^L \times 25^H$	$650^W \times 850^L \times 25^H$	$720^W \times 1080^L \times 25^H$	$720^W \times 920^L \times 25^H$
置物盤數量(quantity of tray)		3	8	12	26
加熱傳導器面積 (heat transfer area)	m^2	2.4	9.8	20.2	37
循環泵(circulating pump)	kW	0.37	0.75	1.5	1.5
加熱器(heater)	kW	4	8	14	18
凝結器(condenser)	mm	$650Φ \times 1070^L$	$1050Φ \times 1200^L$	$1250Φ \times 1400^L$	$1450Φ \times 2000^L$
溫度(temperature)		-40℃~-50℃	-40℃~-50℃	-40℃~-50℃	-40℃~-50℃
凝結能力 (condensing capacity)	kg/H_2O	10	50	100	200
冷凍機 (refrigerator)	kW	3	15	22	30
送風機(blower)	kW	0.75	1.5	2.2	2.2
真空泵(vacuum pump)	kW	1.5	2.2	3.7	2.2+2.2
冷卻水泵 (cooling water pump)	kW	0.37	1.5	2.2	2.2
電氣儀器(electrical apparatus)		Torr 真空計、電子測溫計 (Torr vacuometer and electronic thermometer)			
系統總計(summary of system)					
馬力 220V~380V (horsepower 220V~380V)	kW	5.4	19.8	30.2	40.7
電熱(electrical heater)	kW	4	8	14	18
用水 (water quantity for operating)	m^3/cir	0.3	0.8	1.5	2
用地(install area)	m^2	4	12	18	50

備註(Remarks)：

(1)以上真空乾燥機為標準規格，歡迎訂製其他規格。

As table described above, vacuum freeze-drying units are standard specifications. Welcome to order special specifications.

(2)以上規格若有變更恕不另行通知。

Specifications are subject to change without notice for further improvement.

真空乾燥機規格表
(Specifications Table of Vacuum Freeze-Drying Units)

機型(model) / 項目(item)	單位 (unit)	KLCV-400	KLCV-600	KLCV-1200
乾燥倉(drying chamber)	mm	1650Φ×2600L	1850Φ×3200L	2050Φ×4700L
材質(material)		SS400	SS400	SS400
倉門(cover of chamber)		前門轉 (hinged screw front cover)		
乾燥棚面積 (shelf area)	m^2	34.4	57.4	112.3
固定的有效段 (fixed effective series)		16	18	19
間隔(shelf spacing)	mm	75	75	75
置物盤(plate tray)	mm	$550^W \times 920^L \times 25^H$	$525^W \times 960^L \times 25^H$	$650^W \times 1080^L \times 25^H$
置物盤數量(quantity of tray)		64	108	152
加熱傳導器面積 (heat transfer area)	m^2	68.8	114.9	224.6
循環泵(circulating pump)	kW	2.2	5.6	7.5
加熱器(heater)	kW	24	40	---
凝結器(condenser)	mm	$1650\Phi \times 2200^L$	$1850\Phi \times 2800^L$	$2050\Phi \times 4000^L$
溫度(temperature)		-40℃~-50℃	-40℃~-50℃	-40℃~-50℃
凝結能力 (condensing capacity)	kg/H_2O	400	600	1200
冷凍機(refrigerator)	kW	37.5	56	56×2
真空排氣(vacuum discharging) 真空泵(vacuum pump)	kW	3.75×2	5.5×2	7.5+11
冷卻水泵 (cooling water pump)	kW	3.7	5.6	5.6×2
電氣儀器(electrical apparatus)		Torr 真空計、電子測溫計 (Torr vacuometer and electronic thermometer)		
系統總計(summary of system)				
馬力 220V~380V (horsepower 220V~380V)	kW	53.7	80.4	152.7
電熱(electrical heater)	kW	24	40	---
或 5kg/cm^2G蒸氣(or steam)	Kg/hr	100	150	300
用水 (water quantity for operating)	m^3/cir	2	3	6
用地(install area)	m^2	100	120	200

備註(Remarks)：

(1)以上真空乾燥機為標準規格，歡迎訂製其他規格。
As table described above, vacuum freeze-drying units are standard specifications. Welcome to order special specifications.

(2)以上規格若有變更恕不另行通知。
Specifications are subject to change without notice for further improvement.

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