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股票代码: 002598

MVR离心蒸汽压缩机

MVR Centrifugal steam compressor

单级整体齿轮传动

Single Stage Integral Geared



山东省章丘鼓风机股份有限公司
SHANDONG ZHANGQIU BLOWER CO.,LTD



企业简介

Brief Introduction

山东省章丘鼓风机股份有限公司（以下简称山东章鼓，股票代码：002598）是国家重点风机生产企业，具有五十余年的风机设计、制造技术和经验，是国内值得信赖的罗茨鼓风机生产和销售厂家。公司先后成立了两家中日合资企业，并在美国设立了分公司，成为国内风机行业第一家在国外建立分公司的企业。目前公司已成为集罗茨鼓风机、罗茨真空泵、离心鼓风机、离心真空泵、工业泵、磨机、气力输送设备、电气控制设备、MVR 装置及系统工程等机械产品研发、设计、生产、制造于一体的现代化企业。2011 年公司在深交所成功上市。

山东章鼓拥有享受国务院特殊津贴的专家，享受省、市政府津贴的高级专业人才十余名，拥有国内一流的产品研发设计中心。有“泰山学者”、济南“5150”工程引进的日本专家博士，有享受省、市政府津贴的高级专业人才，先后与清华大学、西安交通大学、江苏大学、山东大学、山东科技大学等高等院校建立了产学研基地并保持着密切的合作关系。公司自主研发了多项具有国际领先和先进水平的新产品，拥有一流的产品研发设计中心，建有省级企业技术中心，具有雄厚的设计、科研、开发、试验、检测能力，处于国内机械行业领先地位。

山东章鼓先后荣获“中国机械 500 强企业”、通用设备制造业“自主创新能力十强”、风机行业“用户满意行业”、“山东省利税五十强企业”等多项荣誉，是国家高新技术产业。

Shandong Zhangqiu Blower Co., Ltd (abbreviated as "ZhangGu", Stock Code: 002598) is one of the most important and trustworthy manufacturers and sellers in China with around 50 years of experience in R & D AND production. It has invested to set up two Chinese-Japanese joint ventures, and one also the first American branch in domestic blower industry. Now ZhangGu has becomes one large scale modernized company designing and producing Roots type blowers/pumps, turbo blowers, industry pumps, mills, pneumatic conveying systems, electric control equipment and MVR systems. ZhangGu was successfully listed in ShenZhen Stock Exchange in July of 2011.

ZhangGu has experts including the gainers of special allowance from the state council, province, and City level, the researchers with tile of "TAISHAN ACADEMICIAN", the foreign talent with Japanese Doctor's degree. ZhangGu also keeps close cooperation with domestic famous universities such as Tsinghua University, Xi'an Jiaotong University, Zhejiang University, Jiangsu University, Shandong University, and Shandong University of Science and Technology. ZhangGu has a provincial level R&D center with leading ability of research, design, test and inspection in domestic machinery industry.

ZhangGu now is ranked the top 500 enterprises in Chinese machinery industry, the top 10 innovation enterprises in the common equipment manufacturing industry. The top 50 taxpayer in Shandong Province, ZhangGu is awarded "The Client Satisfaction Enterprises in Blower Industry", and "The State High-tech. Enterprises".



做大国工匠 建百年章鼓
筑民族品牌 圆中国梦想



国际先进的加工设备

International Advanced Manufacturing Equipment



产品简介 Product Introduction



MVR 离心蒸气压缩机是我公司与西安交通大学共同研制开发的新产品。该系列产品气动性能和结构设计达到国内外同类产品的先进水平，可广泛应用于高浓、高盐污水、食品、制药、氯碱、海水淡化等各类工业系统中。

MVR centrifugal steam compressor is a new product jointly developed by our company and Xi'an jiao tong university. The aerodynamic performance and structure design of this series of products has reached the advanced level of similar products in China and abroad, It can be widely applied to High Concentration, high Salt Sewage, food, pharmaceutical, chlor-alkali, seawater desalination and other industrial systems.

产品特点 Product Features



◆ 每一台 MVR 离心蒸气压缩机都完全基于使用现场的工艺要求专门设计生产，和其它产品相比可以显著降低运行能耗；

◆ MVR 离心蒸气压缩机内所有过流部件都经过空气动力学优化设计，使喘流影响降到最低，使气流在鼓风机内部流畅流动，三元流叶轮设计效率高达 82% 以上；

◆ 采用变频调节，最大限度的满足用户需求，同时配备了防喘振系统，避免 MVR 离心蒸气压缩机进入喘振区，更好的保护设备使之不受到损害；

◆ 集成化的设计可减少占地面积；

◆ 转子经严格动平衡后，振动小，可靠性高，整体噪音低；

◆ 标准或者定制的仪表和控制系统方便压缩机的操作；

◆ 高质量的部件、高规范的执行标准，可以确保压缩机长期可靠运行，并大大减少维修保养费用。

◆ Each MVR centrifugal steam compressor is designed and manufactured entirely on the basis of on-site process requirements, which can significantly reduce operating energy consumption compared with other products;

◆ All wetted parts in MVR centrifugal steam compressor are aerodynamically optimized design to minimize the impact of surge flow, so that the airflow flows smoothly inside the blower, and the design efficiency of ternary flow impeller is up to 82%;

◆ Use variable frequency adjustment to fulfill the clients' requirement maximumly. And provide anti-surge system to avoid MVR centrifugal steam compressor accessing the surge zone to protect it from damage.

◆ Integrated design reduces footprint;

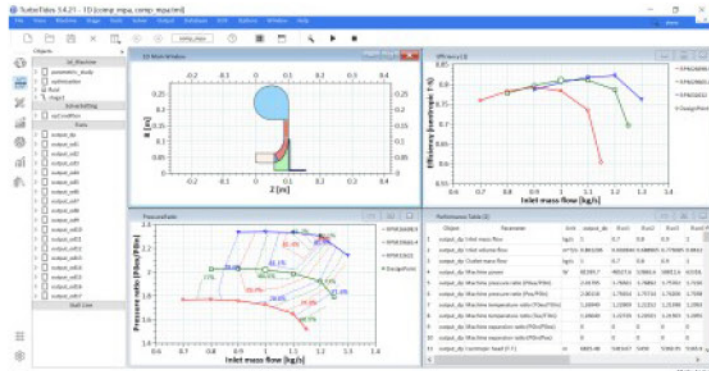
◆ After strict dynamic balance, the rotor has low vibration, high reliability and low overall noise;

◆ Standard or customized instrument and control systems, easy to operate

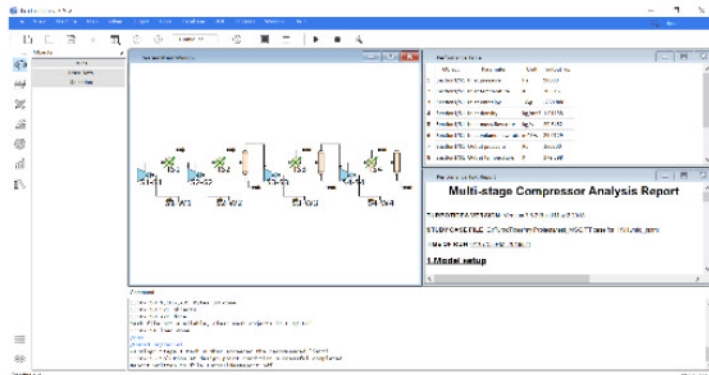
◆ High quality components of high standard can ensure the long-term reliable operation of the steam compressor and greatly reduce maintenance cost.

一体化设计研发平台

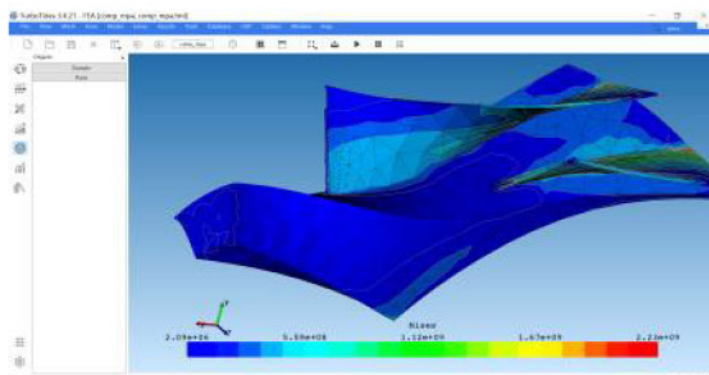
Integrated design and development platform



1D Meanline
• 设计和分析

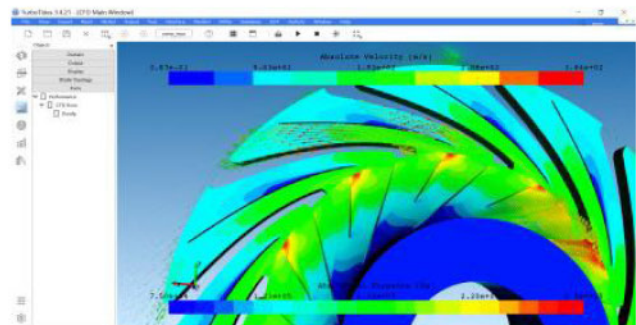
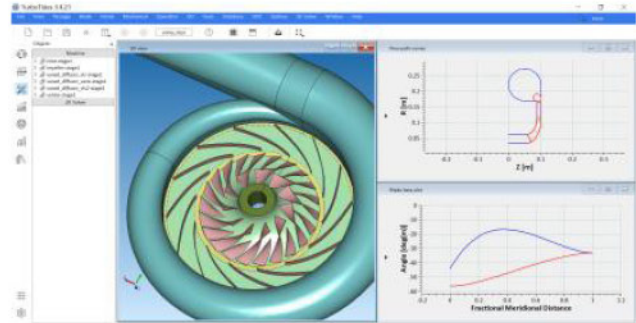
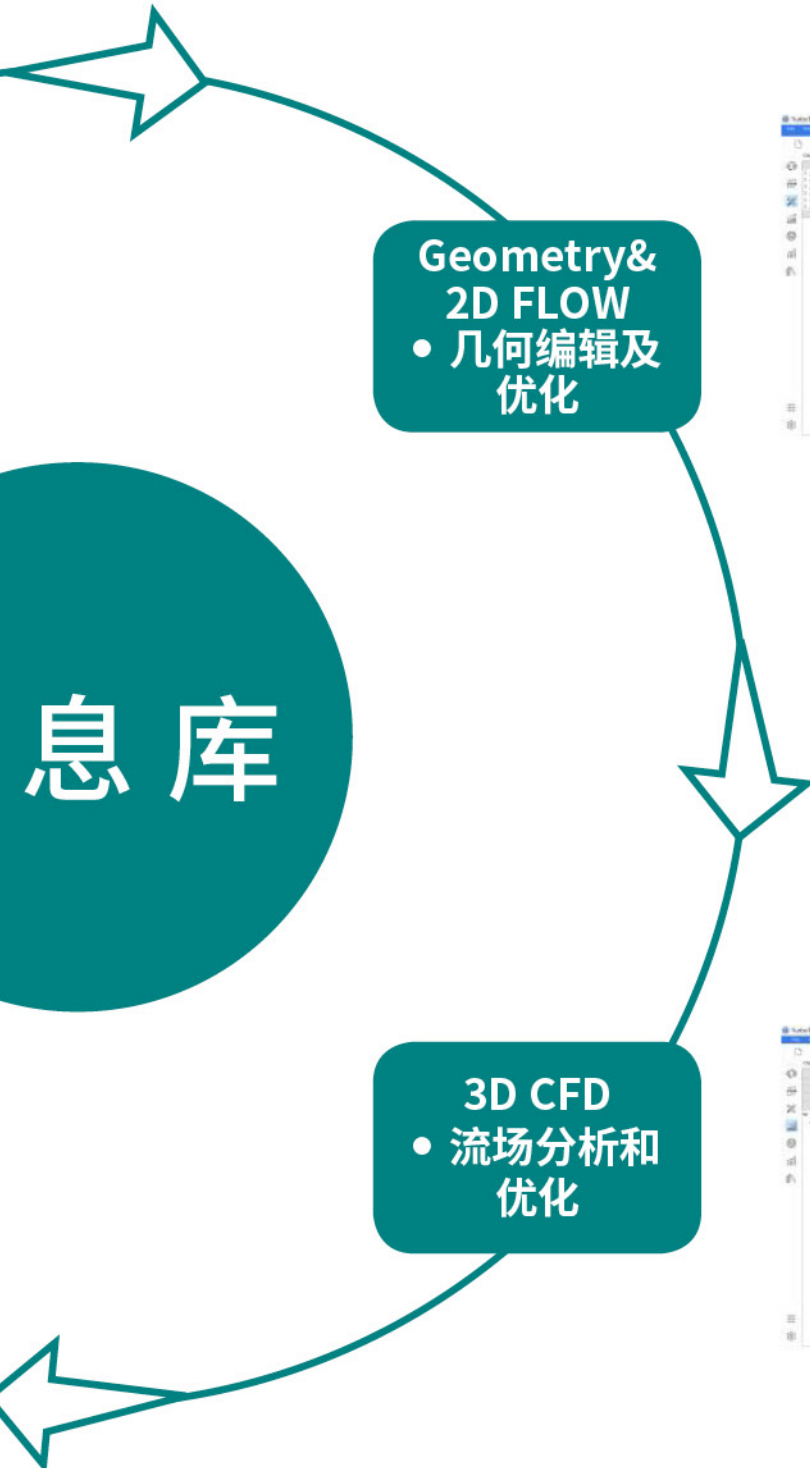


Cycle
• 循环设计



3D FEA
• 结构强度分析
• 转子动力学

信



主要结构 Main Structure



叶轮 Impeller

根据三元流理论设计的叶轮效率高，经严格的精密加工后作动静平衡校正，并通过 1.15 倍额定转速的超速试验，保证叶轮强度。为了满足不同工况的需要，叶轮可选用锻铝、不锈钢和钛合金等多种材料。

The impeller is designed based on ternary flow theory and of high efficiency. The impeller is dynamic and static balanced after precision machining and overspeed tested at 1.15 times of rated speed to guarantee its strength. Stainless steel, titanium alloy and etc materials are available for the impeller for diverse working conditions.



高速转子 High-speed Rotor

高速转子由叶轮、高速齿轮及高速轴组成，叶轮与高速轴采用拉杆连接，靠销钉传递扭矩。为了确保 MVR 离心蒸气压缩机运行平稳可靠，高速转子整体平衡精度达 G1 级。

The high-speed rotor consists of the impeller, high-speed gear and high-speed shaft. Impeller and high-speed shaft are rod mounted, the torque will be transmitted by the pins. The dynamic balance grade of high speed rotor is G1 to ensure the reliable running of MVR centrifugal steam compressor.



有叶扩压器 Vaned Diffuser

机翼型有叶扩压器设计，扩压程度大，整机尺寸小，流动损失小，工况性能好。

Design of airfoil shaped blade diffuser, high diffuser capacity, Small overall size, Low flow loss, good performance under varying operating conditions.



蜗壳 Volute Casing

采用圆截面蜗壳，蜗壳壁的型线设计成对数螺旋线，符合气流的运动规律，对 MVR 离心蒸气压缩机冲击小，因此 MVR 离心蒸气压缩机的流动效率高，振动小，噪音低。

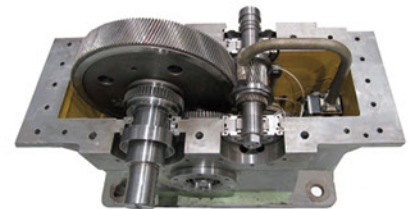
Volute casing is circular section and its wall profile is designed to be logarithmic spiral which conforms to the law of airflow movement and is low impact on MVR centrifugal steam compressor. The MVR centrifugal steam compressor is high flow efficiency, low vibration and low noise.



齿轮 Gear

增速齿轮对为渐开线齿形，大小齿轮表面均经过研磨，渗氮硬化处理，保证 MVR 离心蒸气压缩机高速运转稳定，振动和噪声小，寿命可达 20 年。

The gears are involute tooth profile. Both surface of gearwheel and pinion is grinded and nitride-harden treated to guarantee the stable running of the MVR centrifugal steam compressor at high speed, low vibration and low noise. The lifetime can be 20 years.



轴承 Bearing

高速轴承采用可倾瓦滑动轴承，由多块可绕支点偏转的活动瓦块组成，其抗振性能优良，并可根据载荷变化和转速变化自动调节。

The high-speed bearing is tilting pad slide bearing. It is composed by some pads deflect rotate around the sustainer and of good anti-vibration performance. It can self-adjusted automatically according to the variation of load and speed.



润滑系统 Lubrication System



润滑系统分油箱及润滑油路两部分。机组底座兼作油箱，内设浸入式电加热器和温度变送器，以保证润滑油的温度。润滑油路含主油泵、电动泵、双筒过滤器等。主油泵由低速齿轮轴驱动，机组正常运行时可保证齿轮和轴承有稳定压力的润滑油润滑；电动泵在机组启动前为系统提供预润滑，在紧急情况和停机过程中保持油压稳定，起备用油泵的作用。油过滤器过滤精度 $20\mu\text{m}$ ，并配置过滤器压差过高报警装置。

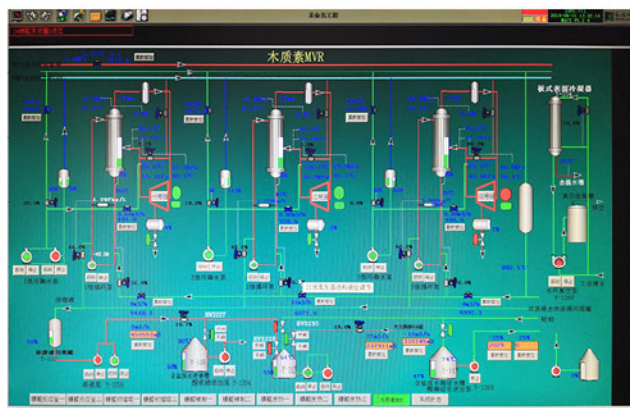
The lubricating system is divided into two parts, the oil tank and the lubricating oil loop. The base of the unit is also used as an oil tank, with an immersed electric heater and a temperature transmitter to ensure the temperature of the lubricating oil. The lubricating oil loop including the main oil pump, electric pump, binocular type oil filter and etc. Main oil pump is driven by the low speed shaft of Gear Box that can ensure stable pressure oil lubrication for the gear and bearing during blower normal running stage; electric pump is used as auxiliary pump providing pre-lubrication for blower system before start and maintain the oil pressure stable in emergency situation or shutdown process. The filtration precision of the oil filter is $20\mu\text{m}$ and equipped by alarm device that would warning when the filter pressure difference is too high.

监测控制系统 Monitoring and Control System (可选配 /Optional)



监测控制系统是专门为监控 MVR 离心蒸气压缩机运行设计制造的，该系统具备启动条件联锁、防喘振控制、辅助油泵随油压变化自动启停、轴承温度过高和轴承振动过大保护等功能。在 MVR 离心蒸气压缩机供油管路上配有油压传感器，在冷却器后配有油温传感器，高速滑动轴承配有测温、测振传感器，MVR 离心蒸气压缩机进出口管路配有测量气温、气压的一次、二次仪表及变送器，这样，可实时监测各种运行参数，保证 MVR 离心蒸气压缩机安全、稳定、可靠的运行。

The monitoring and control system is specialized designed for the operation of MVR centrifugal steam compressor. The system has the functions of interlocking of starting conditions, anti-surge control, auxiliary pump's automatic start and stop with the floating of oil pressure, over-temperature and over-vibration protection for the bearings. Oil pressure sensor is provided in MVR centrifugal steam compressor



oil pipeline, oil temperature sensor is provided after the cooler. Temperature sensor and vibration sensor are provided for high-speed slide bearing; Primary and secondary instrument and transmitters for measuring gas temperature and pressure are provided at suction side and discharge side of MVR centrifugal steam compressor. So all running parameter could be real-time monitored to ensure the MVR centrifugal steam compressor's safe, stable and reliable operation.

MVR 工艺介绍 Process Introduction



MVR 是机械蒸汽再压缩技术 (Mechanical Vapor Recompression) 的简称, 是一种重新利用它自身产生的二次蒸汽的能量, 从而减少对外界能源需求的一项节能技术。

MVR 系统利用蒸汽压缩机压缩二次蒸汽, 将电能转换成热能, 提高二次蒸汽的焓, 被提高热能的二次蒸汽进入系统进行加热, 重复利用。这样原来要废弃的低品质蒸汽就得到了充分的利用, 回收了潜热, 又提高了热效率。循环利用二次蒸汽已有的热能, 从而可以不需要外部蒸汽, 依靠蒸发器自循环来实现蒸发浓缩的目的。

随着人们对 MVR 蒸发工艺节能的不断认识, MVR 工艺在很多行业都得到了广泛的应用, 主要有: 石油、化工行业 (蒸发浓缩、结晶、提纯)、饮料工业、食品及添加剂工业、制药及生物工程、海水淡化、制糖制盐、制奶、制酒、玉米淀粉加工、印染、电厂、环保、废水处理等。

MVR is short for Mechanical Vapor Recompression technology. It is an energy saving technology which can reuse the energy of secondary steam generated by itself so as to reduce the demand for external energy.

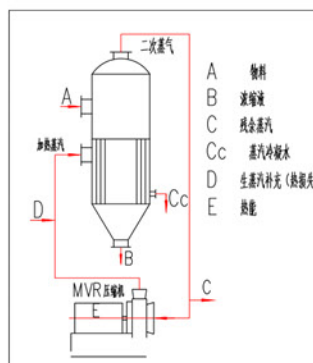
The MVR system uses a steam compressor to compress the secondary steam, convert electrical energy into heat energy, and improve the enthalpy of the secondary steam. This secondary steam with improved heat will enter into the system to be heated and recycled. In this way, the low quality steam that was originally intended to be discarded can be fully utilized, the latent heat can be recovered, and the thermal efficiency can be improved. The existing heat energy of the secondary steam is recycled, so that the external steam is not needed and the evaporator can realize the purpose of steam concentration by self-cycling.

As people constantly understanding of MVR evaporation process and energy saving, MVR process has been widely used in many industries, mainly are: petroleum, chemical industry (evaporation concentration and crystallization, purification), the beverage industry, food and additives, pharmaceutical and biological engineering, water desalination, sugar, salt, milk, wine, corn starch processing, printing and dyeing, power plants, environmental protection, wastewater treatment, etc.

MVR 工艺流程 MVR Technological Process

如图是 MVR 基本的流程图。不同的物料蒸发工艺有所不同, 所用设备也不全相同, 但物料走向是基本相同的。根据工艺流程可知, 其核心设备为 MVR 压缩机和蒸发器, 它们直接影响整个系统的效率。

Figure is the basic flow chart of MVR. The evaporation process for different materials is different, and the equipment used is not the same, but the direction of materials is basically the same. According to the process flow, the core equipment is MVR compressor and evaporator, which directly affect the efficiency of the whole system.



MVR 比传统单效蒸发

节能 90% 以上

MVR 比传统三效蒸发

节能 70% 以上

MVR 离心蒸汽压缩机与传统多效蒸发能耗对比

Energy consumption comparison of MVR centrifugal steam compressor with traditional multi - effect evaporation

- ◆ 完全摆脱了对蒸汽锅炉的依赖，减少了 SO₂、CO₂ 以及粉尘和固体废渣的排放；
- ◆ 占地面积小，仅为传统蒸发器的 1/10；
- ◆ 节约了传统浓缩所需要的大量的循环水；
- ◆ 自动化程度高，控制精确，尤其适用于热敏性物料浓缩、结晶。
- ◆ Completely get rid of the dependence on the steam boiler, reduce the emission of SO₂, CO₂, dust and solid waste
- ◆ Less footprint, only 1/10 of the traditional evaporator
- ◆ Much cycling water is saved compare to traditional concentration process.
- ◆ High degree of automation, accurate control, especially suitable for heat sensitive material concentration, crystallization.

多效蒸发（以 10 吨每小时三效为例）与 MVR 能耗对比

Energy consumption comparison of multi-effect evaporation (take sample of 10 ton/h of three-effect) with MVR

项目 project	蒸气 steam		电 electricity	
	使用量 (吨)	费用 (元)	使用量 (度)	费用 (元)
三效 triple effect	5	1000	100	70
MVR	0.2	40	500	350
每年节约 Yearly cost saving	((1000-40) + (70-350)) × 20 × 300 = 408 万元			

按蒸气 200 元 / 吨，电费 0.7 元 / 度，1 年 300 天，1 天 20 小时计算

产品规格 Product Specifications

项目 project	范围 range
单台质量流量 (MVR 系统蒸发量) Unit mass flow rate (MVR system evaporation capacity)	1~200 t/h
体积流量 Volumetric flow rate	3000~280000 m ³ /h
产品单台单级饱和蒸气温升 Unit saturated steam temperature rise (single stage)	6~24°C
叶轮转速 rotating speed of impeller	5000~30000 r/min
单级最高压比 Maximum pressure ratio (single stage)	2.5

可以通过多台串联实现更高温升，或多台并联实现更大流量。

Higher temperature rise can be achieved through multiple series, or higher flow rate can be achieved by multiple parallel sets

部分应用案例 Partial Reference List



项目名称	济南圣泉 MVR 蒸发浓缩系统	饱和温升	15℃
蒸发物料	木质素硫酸盐	电机功率	450kW
蒸发量	9 吨 / 小时	蒸发器形式	强制循环

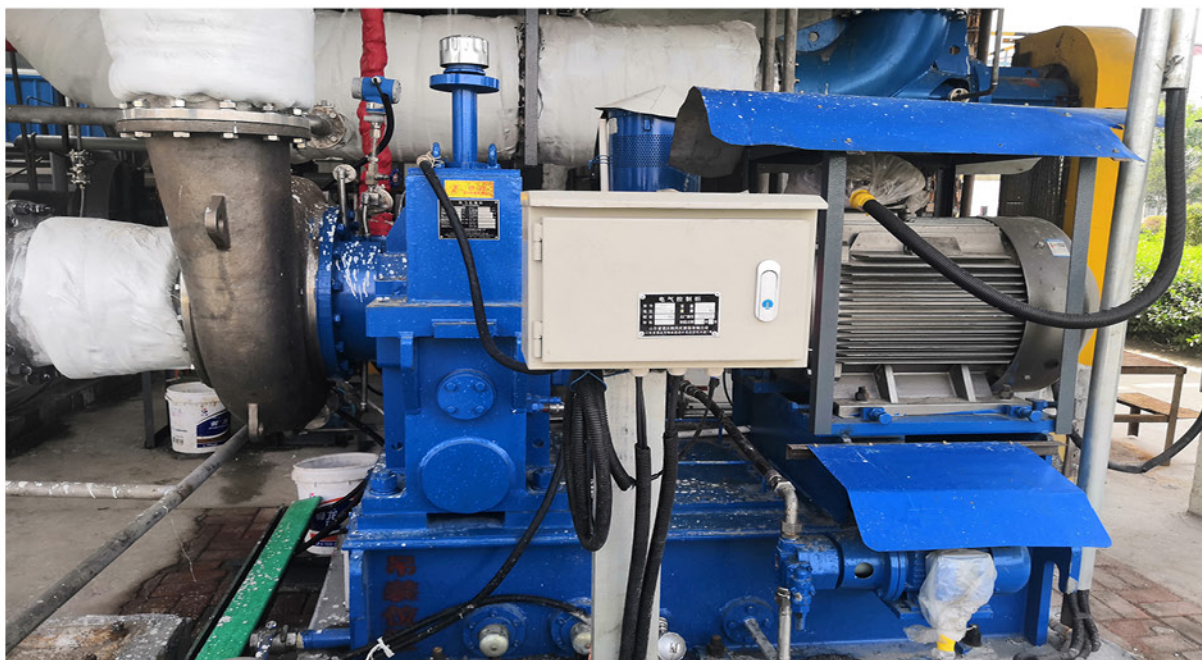


项目名称	河北允升 MVR 蒸发结晶系统	饱和温升	20℃
蒸发物料	氯化铵	电机功率	220kW
蒸发量	3.42 吨 / 小时	蒸发器形式	强制循环

部分应用案例 Partial Reference List



项目名称	河北昂立 MVR 蒸发结晶系统	饱和温升	14°C
蒸发物料	氯化钠	电机功率	160kW
蒸发量	3 吨 / 小时	蒸发器形式	强制循环



项目名称	菏泽金正大 MVR 蒸发浓缩系统	饱和温升	13°C
蒸发物料	硝酸	电机功率	75kW
蒸发量	1.5 吨 / 小时	蒸发器形式	强制循环

部分应用案例 Partial Reference List



项目名称	宁夏中盛 MVR 蒸发结晶系统	饱和温升	16℃
蒸发物料	氯化钠	电机功率	355kW
蒸发量	7.05 吨 / 小时	蒸发器形式	强制循环



项目名称	烟台安德利果胶 MVR 蒸发结晶系统	饱和温升	11℃
蒸发物料	果胶	电机功率	800kW
蒸发量	26 吨 / 小时	蒸发器形式	强制循环



我们在全国各地共设有56个办事处，目前除台湾外全国33个省份行政区域均有完善的销售和服务网络。能够及时便捷的为您提供售前、售中和售后服务，从中了解您的需求，在满足客户定制化需求同时，不断完善服务及质量体系。

We set up 56 sales offices all over China covers 33 provinces Administrative Region except Taiwan. It is perfectly organized sale and service network will offer prompt presale, insale and aftersale service. Your requirements would be fully realized by our tailor made products and improving service and quality system.



山东章鼓官方网站



山东章鼓微信公众平台

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