变容量家庭能源中心制冷兼制热水模式性能实验研究［刊，中]

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摘　要　现有的多功能热泵机组的制冷兼制热水模式存在结构复杂、能量控制难以满足需求等问题，为此，提出基于数码涡旋压缩机的变容量家庭能源中心系统，并确定制冷兼制热水模式的机组性能系数计算方法。实验分析对比制冷兼制热水模式和单独制冷模式的性能，结果表明，与单独制冷模式相比，制冷兼制热水模式的制冷量有所衰减，但机组的总能量输出和性能系数分别提高了 17.3%和 36.8%。实验研究制冷兼制热水模式在水箱初始温度、不同压缩机负荷和不同环境温度下的动态特性和性能表现。通过分析该模式在各种工况下的性能变化规律，总结控制策略，可保证该模式的安全高效运行。

关键词　家庭能源中心；机组性能系数；控制策略；变容量压缩机；空调；热水

Experimental Study on Space Cooling & Water Heating Mode of Domestic Energy System with Variable Capacity Compressor

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Abstract To solve the problems of complex structure and unsuitable capacity control of present multi-function heat pump system, domestic energy system is introduced. A new system performance indicator is chosen to describe the performance of space cooling & water heating mode. By comparison with space cooling only mode, this mode has been proved with a little less cooling capacity but with higher total system performance. Series of experiments are conducted with different tank average initial water temperature, compressor load and outdoor ambient temperature conditions. By analysis of transient characteristics and system performance, the performance rules are concluded. Furthermore, the control strategy is proposed to insure the safe and efficient operation of space cooling & water heating mode.

Keywords domestic energy system; COP; control strategy; variable capacity compressor; air conditioning; hot water

热舒适驱动的空调能量设计因子研究［刊，中］

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摘　要　为确定热舒适需求与空调节能设计过程中的关键能量设计要素之间的关联性，提出了一种基于热舒适的空调能量设计因子提取及其重要度计算方法。在热舒适驱动的空调节能设计过程框架的基础上，建立了基于热舒适需求的功能质量屋，并将热舒适性转化为空调功能及权重等设计信息；分析功能的能量特性，针对与能耗相关的功能，给出了能量设计因子提取策略，以及能量设计因子对热舒适及能耗综合影响程度量化方法。以家用空调为例，提取了基于热舒适的能量设计因子，对容积效率和传热系数两项耦合因子进行了分解，并对整体层能量设计因子的热舒适性及能耗的影响系数进行计算，按综合影响系数由大到小排序，结果为压缩机功率、系统控制方式、通风量和换热量。

关键词　家用空调；能量设计因子；热舒适；节能设计

Study on Energy Design Factors of Air Conditioning Driven by Thermal Comfort

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Abstract In order to determining the relevance between thermal comfort and key energy design elements during energy-saving design process, the method of extracting energy design factors of air conditioning and calculating its weight is proposed. The house of quality based on thermal comfort is built with the energy-saving design frame driven by thermal comfort. The thermal comfort requirements are converted to function and weight of air conditioning. The energy characteristic of the function is analyzed, for functions dependent with energy, the extract means of energy design factors is provided, and the method of calculating thermal comfort and energy consumption influence degree is put forward. Taking the household air conditioning as a case study, the energy design factors based on thermal comfort are extracted, two coupled factors, volume efficiency and heat transfer coefficient are decoupled, and thermal comfort and energy consumption influence coefficient of energy design factors in overall layer are calculated, the result according to comprehensive influence efficient in descending order is compressor power, system control mode, ventilation quality and heat exchange amount.

Keywords   household air conditioning; energy design factors; thermal comfort; energy-saving design

反渗透膜分离性能及其在制冷空调中的应用［刊，中］

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摘　要　介绍了反渗透膜的分离机理，归纳了多种分离过程理论模型的通量公式、应用场合及其局限性，综述了操作压力、料液温度、料液浓度以及料液流速等特性参数对反渗透膜分离性能的影响，解读了反渗透膜分离技术在制冷空调中的应用研究，为反渗透膜分离技术在制冷空调行业的应用提供了参考。

关键词　制冷空调；反渗透膜；综述；分离模型；应用

Separation Performance of the Reverse Osmosis Membrane and Its Applied Research in

Air-conditioning

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Abstract　The separation mechanism of reverse osmosis membrane was described. Flux formulas, applications and limitations of various theoretical separation models were summarized here. The effects operating pressure, feed temperature, feed concentration and feed flow rate have on performance of the reverse osmosis membrane separation were analyzed systematically. Finally, the applications using reverse osmosis membrane separation technology in refrigeration and air conditioning industry were focusing demonstrated, proving a reference for applications for the reverse osmosis membrane separation technology in refrigeration and air conditioning industry.

Keywords　air-conditioning; reverse osmosis; review; separation model; application

两段式喷嘴引射器的引射制冷系统性能实验研究［刊，中］

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摘　要　对采用两段式喷嘴引射器的两相流引射制冷系统进行了实验研究，并将两段式喷嘴的引射比及其系统 COP 分别与拉法尔喷嘴引射器的引射比及其系统 COP 进行了比较。实验结果表明：在冷凝/蒸发温度为 45 ℃/1 ℃工况下，使用不同几何尺寸两段式喷嘴引射器的引射比均大于拉法尔喷嘴引射器的引射比，最大提高了约 18%；使用两段式喷嘴引射器的制冷系统 COP 大于使用拉法尔喷嘴引射器的制冷系统 COP，最大提高了约 12%；在蒸发温度为 1 ℃条件下，两段式喷嘴引射器及拉法尔喷嘴引射器的引射比均在冷凝温度为 45 ℃时达到最大值，而在冷凝温度为 50 ℃条件下，两种引射器的引射比均在蒸发温度为 3 ℃时达到最大值。

关键词　引射器；两相流；两段式喷嘴；引射比

Experimental Study on Performance of Dual-serial-throat Nozzle Ejector in Two-phase Ejector Refrigeration Cycle System

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Abstract The two-phase ejector refrigeration cycle (TPERC) system with a dual-serial-throat nozzle

ejector was investigated experimentally, and the entrainment ratio of the ejector and the COP of the system were compared with those of the ejector with Laval nozzle and the TPERC system respectively. The experimental results indicate that the entrainment ratios of the dual-serial-throat nozzle ejectors with different geometric size are greater than those of the Laval nozzle ejectors under the working condition of the evaporating/condensing temperatures 1 ℃/45 ℃, the maximum increment of the entrainment ratio is about 18%, and the COP of the TPERC system with dual-serial-throat nozzle ejector is greater than that of the TPERC system with Laval nozzle ejector, the maximum increment of the COP is about 12%. Under the condition of the fixed evaporating temperature 1 ℃, the entrainment ratios of both the dual-serial-throat nozzle ejector and the Laval nozzle ejector achieve the maximum values as the condensing temperature is about 45 ℃. Under the condition of the fixed condensing temperature 50 ℃, the entrainment ratios of the two types of ejectors achieve the maximum values as the evaporating temperature is about 3 ℃.

Keywords ejector; two-phase flow; dual-serial-throat nozzle; entrainment ratio

倾斜状态下板翅式换热器封头物流分配特性的实验 ［刊，中］

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摘 要 海上平台受到海浪的作用会发生晃动和倾斜，从而影响板翅式换热器的入口物流分配特性。通过空气—水两相物流分配实验系统，分别进行封头结构水平状态和倾斜状态下的单相以及气液两相实验，获得不同实验工况下的封头物流分配特性，研究倾斜对封头物流分配的影响，从而为换热器的安装及工艺的改进提供依据。结果表明：水平状态下物流分配受惯性力的影响，不均匀度随雷诺数和气液比的增加而增大；倾斜状态下流体受到惯性力和重力的双重影响，物流分配均匀程度显著低于水平状态，倾斜角越大物流分配越不均匀，气液比越大物流分配受倾斜影响程度越大；固定封头或安装换热器时应严格保证其水平/竖直状态，或者通过液化工艺及换热器设计的改进消除倾斜的影响。

关键词 板翅式换热器；封头结构；倾斜；气液两相；分配特性

Experimental Investigation on Flow Distribution in the Header of Plate-fin Heat Exchanger in Tilt State

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Abstract   Offshore platforms will shake and tilt because of marine motion, and that will influence flow distribution in the header structure of plate-fin heat exchanger. With air-water two-phase flow distribution experimental apparatus, pure water/air and gas-liquid two-phase experiments in horizontal and tilt state were operated. The effect of gas-liquid ratio and tilt angle on flow distribution in the header of plate-fin heat exchanger in tilt state were studied. Compared with the flow distribution in different experimental conditions, we concluded how much tilt influences the flow distribution in the header and got the basis for the installation of plate-pin heat exchanger and process improvements. The results show that flow distribution in static state is subject to the influence of the inertial force, the flow distribution unevenness increases with the increase of the inlet flow and gas-liquid ratio. In tilt state, flow distribution is subject to the influence of both inertial force and gravity, and flow distribution evenness is much lower than the static state. Flow distribution unevenness increases with the increase of tilt angle, and gets more sensitive to tilt when gas-liquid ratio increases. We should strictly ensure horizontal/vertical state when fix header structure and install heat exchanger. Meanwhile the influence of tilt can be eliminated through the improvement of liquefaction process and heat exchanger design.

Keywords   plate fin heat exchanger; header structure; tilt; two-phase; flow distribution

果蔬用敞开式陈列柜温湿度场分布特性实验研究［刊，中］

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摘　要   为研究带单层风幕的敞开式果蔬陈列柜温湿度分布规律，采用了一种立式敞开式陈列柜实验平台作为研究对象，分析陈列柜稳态运行阶段回温、降温和节能帘对温湿度场分布特性的影响。实验结果表明：在无节能帘条件下，回温工况结束时温湿度场比降温工况均匀，其温度、相对湿度分布的变异系数分别为 0.25、0.08。陈列柜左部温度和相对湿度均低于右部；4 层搁架温度、相对湿度分布差异显著（P<0.05）。稳态运行阶段，搁架温度和相对湿度分布呈周期性振荡，周期约为 17min；运用线性回归方法建立各测点相对湿度关于温度的函数模型，回归方程表明：相对湿度与温度呈线性正相关；与无节能帘时相比，有节能帘条件下的柜内平均相对湿度高 5.74%RH，

平均温度低 0.43℃，温度、相对湿度的波动幅度小，降温时间短和回温时间长。研究结果为果蔬用敞开式陈列柜性能的优化提供参考。

关键词　陈列柜；温度；湿度；分布

Experimental Study on Distribution of Temperature and Humidity Field in Vertical Open Display Cabinet for Fruits and Vegetables

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Abstract　In order to investigate the distribution of temperature and relative humidity of the fruit and vegetable open display cabinet with single-band air curtain, an experimental platform of the vertical open display cabinet was used for refrigeration test. The distribution characteristics of temperature and relative humidity of the testing display cabinet under the cooling and temperature raising conditions was analyzed. The effect of night covers was also explored. The experimental results showed that the temperature and humidity are well-distributed under temperature raising condition with the coefficient variation (CV) of temperature and the relative humidity distribution is 0.25 and 0.08 respectively. The temperature and relative humidity of the right of the display cabinet are higher than those of the left horizontally. The distribution of temperature and relative humidity in four shelves differs significantly (P<0.05) in the orthogonal direction. During the steady-state operation the temperature and relative humidity distribution in four shelves is periodic oscillation and the period is about 17min. To study the overall temperature and relative humidity of the display cabinet, the linear regression method was used to predict the effect of the relative humidity on the temperature. The regression model showed that temperature is linear with the relative humidity. Night covers can keep the relative humidity and the amplitude of temperature with minor changes, shorten the cooling time and prolong the temperature raising time. Compared with no night covers, the average relative humidity is higher by 5.74%RH and average temperature is lower by 0.43℃. The results will provide references to optimize the performance design of the fruit and vegetable open display cabinet.

Keywords　display cabinet; temperature; relative humidity; distribution

磁性纳米制冷剂冷却回路热磁对流特性研究［刊，中］

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摘　要　建立磁性纳米制冷剂 Fe_3O_4-R600a 冷却回路的热磁对流特性实验系统，研究了磁场分布、磁场强度、加热功率、冷却温度等对热磁对流特性的影响。结果表明：外磁场对磁性纳米流体热磁对流过程的影响非常明显，可无须机械泵驱动而实现能量的自主传递过程，冷却回路中的磁流体循环流动和传热性能取决于外磁场与温度的协同作用，应用外磁场有效可控制冷却回路的运行特性。

关键词　制冷剂；冷却；磁场；热磁对流

Study on Thermomagnetic Convection Characteristics of a Cooling Device Using Magnetic Nano-refrigerant

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Abstract　The experimental system of a cooling device using Fe3O4-R600a as magnetic nano-refrigerant was built up. And the influences of magnetic field distribution, magnetic field intensity, heat load, cooling temperature were discussed. The results show that the effect of the device was improved obviously by external magnetic field, and the heat was transferred by the circulating fluid without a pump. On the meantime, synergic function between the external magnetic field and the thermal field has impact on the velocity of the working fluid and the cooling performance of the device. Using external magnetic field, the cooling performance of the device also can be effectively controlled.

Keywords　refrigerant; cooling; magnetic field; thermomagnetic convection

基于空间扫描思想的复杂蒸发冷却式换热器通用模拟方法［刊，中］

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摘 要 针对现有蒸发冷却式换热器数值计算模型中存在的不足，提出了基于空间扫描思想的复杂蒸发冷却式换热器的通用模拟方法。该方法将三维复杂蒸发冷换热器按空间划分为若干个节点，每个节点视为独立的微型换热器，利用流体在节点之间的流动建立节点联系，根据稳定流动和稳态换热时节点之间的能量和质量守恒关系，构建迭代更新算法，利用扫描迭代的方法对模型进行求解。将无填料型和有填料两种闭式冷却塔的模拟结果与文献实验数据进行对比，结果表明：所建模型具有良好的精度，可用于复杂结构、复杂流动、多模态蒸发冷却式换热器的仿真。

关键词 蒸发冷却；换热器；模拟仿真；节点；传热传质

A General Modeling Approach for Complex Evaporative Cooling Heat Exchanger Based on Spatial Scanning

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Abstract In order to overcome the disadvantages of existing modeling methods of the complex evaporative cooling heat exchangers, a general modeling approach based on spatial scanning theory is proposed. In this approach,,the 3-D heat exchanger is divided into calculation nodes according to its spatial location. Each node is regarded as a micro heat exchanger, and connected with each other through air, water/solution, and/or refrigerant. An iterative algorithm is developed based on conservation of energy and mass of nodes in steady flow and steady-state heat transfer. Finally, the model is verified by comparing the simulated results and the experimental results of two closed-type wet cooling towers. Results show that the proposed model has highly accurate and reliable. This model can be used to simulate the performance of the evaporative cooling heat exchanger with complicated configurations and flow under different modes.

Keywords evaporative cooling; heat exchanger; simulation; heat transfer and mass transfer

表面处理对微通道换热器湿工况性能及长效特性的影响［刊，中］

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摘 要 对翅片间距为 1.1 mm 的微通道换热器进行了亲水和疏水表面处理，并对其不同工况下的性能进行了实验

研究，分析了表面处理对微通道换热器湿工况性能和长效特性的影响。实验表明，疏水表面处理在低风速下会造成换热器性能衰减：与原换热器相比，经过疏水表面处理的换热器换热量最大减小 14%，衰减随着风速的变大而减小；而压降除了高风速高湿度工况，其余工况下均升高 130%以上。亲水表面处理对换热器性能影响较小：与原换热器相比，经过亲水表面处理的换热器在不同工况下性能衰减 2%~8%；压降仅在高湿度低风速下明显变大 17%，其余大部分工况得到改善，在高湿度高风速下压降仅为原换热器的 50%。亲水表面处理在防腐蚀方面具有一定作用，同时进行盐雾腐蚀 260 h 后，表面亲水处理的换热器在不同工况下比原换热器性能提升 4%~6%，压降降低 14%~16%。

关键词　微通道换热器；表面处理；换热性能；压降；盐雾腐蚀

Research on the Wet Performance and Long-term Characteristics of Microchannel Heat Exchanger with Surface Coating

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Abstract　The wet performance of microchannel heat exchanger (Fin Pitch=1.1 mm) with hydrophobic, hydrophilic and without surface coating were studied under different conditions experimentally. The results indicated that hydrophobic surface coating had bad effects on air side performance: the capacity decreased by 14% under low air velocity and the decrease became less with the increase of air velocity; the pressure drop increased at least by 130% under different conditions except the condition of high air velocity & humidity. The capacity of hydrophilic heat exchanger decreased by 2%-8% under different conditions; the pressure drop decreased up to 50% under high air velocity & humidity and got improved under most conditions except for the 17% decrease under the condition of low air velocity & high humidity. Air side performance of microchannel heat exchanger with hydrophilic and without surface coating were studied after 260h salt spray corrosion. The capacity of hydrophilic coating heat exchanger increased by 4%-6% compared to the one without surface coating, and pressure drop decreased by 14%-16%. The result indicated that hydrophilic coating was good for anti-corrosion.

水平光滑细管内 **R1234ze** 冷凝换热特性实验研究［刊，中］

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摘　要　对流体 R1234ze 在内径 2 mm 的水平光滑圆管内的冷凝换热特性进行了实验研究，设定流体饱和温度为 35 ℃、40 ℃，质量流量为 100~400 kg/(m^2·s)，热流密度为 4~22 kW/m^2。实验获得了 R1234ze 在不同工况下的冷凝换热系数和摩擦压降。发现 R1234ze 的冷凝换热系数范围在 1.5 到 8 kW/(m^2·K)之间，且随干度的增加而增加，随质量流量的增大而增大，随饱和温度的升高而降低，比在相同工况下 R134a 、R32 的换热系数分别平均低约 22%和 31%。R1234ze 的摩擦压降随质量流量增加而增大，随饱和温度的升高而降低，高于相同工况下 R32 的摩擦压降。并将本次实验值与其它经典换热模型和压降模型进行了对比分析，发现 Baird 等人的模型对本次实验的换热系数预测较好，对其它文献中的相似数据点预测也较好。Müller- Heck 模型对摩擦压降预测最好。

关键词　制冷剂；R1234ze；冷凝换热系数；摩擦压降；水平光滑管

Heat Transfer Characteristics for Condensation of R1234ze in a Horizontal Small Tube

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Abstract　The condensation heat transfer coefficients of R1234ze in a single circular minitube of 2 mm inner diameter were investigated experimentally. The experiment are conducted at saturation temperature of 35 ℃、40 ℃, mass flux of 100~400 kg/(m^2·s) and heat flux of 4~22 kW/m. The test results showed that the range of heat transfer coefficients is 1.5~8 kW/(m^2·K). Both the heat transfer coefficients and frictional pressure drop of R1234ze increase with the rise of mass flux, and decrease with the rise of saturation temperature. Compared with R134a and R32, the heat transfer coefficient of R1234ze is relatively low (22% lower than R134a and 31% lower than R32), and the frictional pressure drop of R32 is higher than R1234ze. After comparing the results with several typical predicted correlations, it is shown that Baird model can predict the experimental heat transfer coefficients well relatively and Müller- Heck model can predict the experimental frictional pressure drop with best accuracy.

Keywords　refrigerant ; R1234ze; condensation heat transfer coefficients; frictional pressure drop

二氧化碳套管式气冷器换热性能的实验研究［刊，中］

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摘 要 总结了不同形式 CO_2 气冷器的国内外研究现状，对直管、矩形螺旋和圆形螺旋三种套管式气冷器性能进行模拟，提出用单位压降换热量来评价超临界条件下气冷器的性能，根据模拟结果设计了一套矩形螺旋套管式气冷器，实验研究了气冷器的 CO_2 入口压力、进水流量和进水温度对气冷器传热系数、换热量、COP 以及换热器效能等性能的影响。结果表明：当气冷器 CO_2 进口压力为 8 MPa，进水流量在 1.56 kg/min 和进水温度在 9 ℃时气冷器性能较优，系统 COP 最大可达 2.85。研究结果为 CO_2 热泵热水器中的实际应用提供参考。

关键词 换热性能；实验研究； CO_2 热泵热水器；套管式气体冷却器

Experimental Study on Heat Transfer Performance of CO$_2$ Casing Tube Gas Cooler

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Abstract The CO$_2$ gas cooler of different forms having been studied were summarized at home and abroad. The performance of three gas coolers，straight pipe, rectangular spiral pipe and circular spiral pipe were simulated, putting forward the heat transfer amount of unit pressure drop used for evaluating the gas cooler performance in the supercritical condition. According to the simulated result, a set of rectangular spiral casing gas cooler was designed and the influences of CO$_2$ inlet pressure, inlet water flow and inlet water temperature on heat transfer coefficient, heat transfer amount, COP and heat exchanger efficiency were studied experimentally. The results show that the system COP can reach 2.85 when CO$_2$ inlet pressure is 8MPa, inlet water flow is 1.56kg/min and inlet water temperature is 9℃. The results can provide reference for the practical application of the CO$_2$ heat pump water heater.

Keywords heat transfer performance; experimental study; CO$_2$ heat pump water heater; casing tube in tube gas cooler

单面波浪平板脉动热管的传热性能［刊，中］

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摘 要 对一种单面波浪平板脉动热管的传热性能进行了实验研究，分析在空气强制对流冷却条件下充液率、加热功率、倾角等因素对其传热性能的影响。研究结果表明，除 0°倾角外，脉动热管的最佳充液率为 20%～30%，倾斜角度对脉动热管传热性能的影响很小，但 90°时相对最好。脉动热管在 0°放置时其传热性能较差，在低充液率的情况下甚至丧失脉动效果，主要是

工质回流不畅的原因，与平板脉动热管的槽道设计有很大关系。此外低加热功率时热管传热性能存在波动，有时甚至不能启动。

关键词 脉动热管；传热性能；梯形通道；影响因素

Heat Transfer Performance of Flat Pulsating Heat Pipe with Single-sided Wave Plate

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Abstract Heat transfer performance of a flat pulsating heat pipe with single-sided wave plate was experimentally investigated. Influence factors of heat transfer performance were analyzed under the effect of forced air convection cooling conditions, including liquid filling ratio, heating power and inclination angle. The result show that the best liquid filling ratio of pulsating heat pipe is 20%~30% except laid at 0° angle. The effect of inclination angle on the heat transfer performance of pulsating heat pipe is very small, but 90° is relatively the best. Heat transfer performance of heat pipe is poor when it is laid at 0° angle, even lose pulsating effect when liquid filling ratio is low .The main reason is that the backflow of working fluid is difficulty, having a lot to do with the design of groove of plate pulsating heat pipe. In addition, heat transfer performance of heat pipe may be undulated when heating power is low, sometimes heat pipe even can't start.

Keywords pulsating heat pipe; heat transfer performance; trapezoidal channel; influence factors

不同提升高度对气泡泵性能影响的理论与实验研究［刊，中］

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摘 要 为了能够更加准确的掌握影响气泡泵运行性能的参数，提升 Einstein 制冷循环的性能，在大气压下以饱和水为工质，建立了气泡泵工作的理论模型，开展了相同沉浸比下不同的提升高度对气泡泵提升性能影响的实验。根据理论分析和实验结果，发现在保持其他影响因素不变情况下，理论值与实验值基本趋势一致，液体提升量与竖直提升高度成反比，提升量相差最大可达 0.82 g/s；提升效率与提升高度成正比，提升效率最大减少量达 10.16 %，对整个制冷系统的性能有重要影响。

关键词 制冷；气泡泵；两相流；竖直提升管；Einstein 循环

The Theoretical and Experimental Research on Performance of Bubble Pump with Different Lift Height

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Abstract　In order to grasp the influence parameters of bubble pump performance more accurately and improve the performance of Einstein refrigeration, the theoretical model and experiment on bubble pump were carried out with water as the working fluid at atmospheric pressure by using different lift height under the same immersion ratio. According to the theoretical and experimental results, it is found that under the condition of the other factors unchanged, the theoretical and experimental results have the same trend; the amount of the lifted liquid is inversely proportional to the lift height, the lifting capacity difference can reach to 0.82g/s; the lift height is proportional to the lifting efficiency, and the maximum lifting efficiency difference can reach to 10.16%, which has an important effect on the whole refrigeration system.

Keywords　refrigeration; bubble pump; two phase flow; vertical lift tube; Einstein cycle

载冷气泡直接接触式对流换热过程熵产分析［刊，中］

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摘　要　研究了载冷气泡和制冰溶液的直接接触换热过程，建立了对流换热微分方程，得到了努塞尔数和雷诺数、普朗特数的传热关联式，通过实验数据验证了模型的准确性。利用传热关联式，针对换热过程的熵产作了分析，在以气泡直径作为换热特征尺寸下，换热过程中熵产数随着雷诺数的变化存在最小值。研究为直接接触式对流换热过程的优化提供了理论基础。

关键词　直接接触式换热；载冷气泡；熵产

Entropy Generation Analysis of Direct-Contact Heat Transfer between a Single Cold Air Bubble and Immiscible Liquid

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Abstract　In terms of direct-contact heat transfer process between cold air bubbles and immiscible liquid, the convection heat transfer equation was established and solved numerically. A correlation between Nu and Re as

well as Pr was obtained, and the validation of the model was verified by comparing the theoretical value and the experimental data. Entropy generation during the heat transfer process was studied. The variation of entropy generation rate was presented regarding Re. An optimal Re would lead to a minimum entropy generation during the heat transfer process. The research provides a theoretical basis of optimizing the direct-contact heat transfer process.

Keywords   direct-contact heat transfer; cold air bubbles; entropy generation

散热器散热过程的场协同分析 [刊，中]

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摘 要   大型计算机服务器 CPU 的散热问题始终是业内专家关注的焦点，为此推出了多种不同类型的 CPU 散热装置。为了提高散热器对流换热的性能除了采用强化换热措施外，流体速度场与温度梯度之间的协同程度也将影响其换热效果。本文对一种新型结构的芯片散热器进行了实验研究，通过 PIV 实验测试以及运用流固耦合进行数值计算，获取了实验风道中散热器周围的速度场和温度场。在此基础上利用场协同理论对其换热过程进行了分析，得出了颇有参考价值的研究结论。

关键词   散热器；PIV；场协同分析；数值计算

Analysis for Fields Synergy in Heat Dissipation Process of Heat Sink

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Abstract   In a mainframe computer system, CPU cooling problem has always been the focus of industry Experts. Some novel heat sinks were presented to strengthen the heat transfer effect during heat transfer process. A mathematic model of the CPU heat sink in the experiment duct was developed and compared with experiments. Based on the experimentresearchof the CPU heat sink, the velocity field and the velocity gradient field of the heat sink in the duct were acquired by PIV and fluid-solid coupling numerical calculation. It is showed that the synergy of the velocity field and the velocity gradient field in an entire flow domain would affect heat convection of CPU heat sink. The results of the study was possible to improve the performance and the design of CPU cooling system.

Keywords   heat sink；PIV；field synergy；numerical calculation

气体分配器结构对压力波制冷机内流动及性能的影响 [刊，中]

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摘　要　采用理论分析和实验研究相结合的方法，探讨了喷管型式、相对充气时间等气体分配器结构因素对压力波制冷机内流动及性能的影响。结果表明：膨胀比 ε 在 2.0~12.0 的范围内，采用收缩型喷管形成的入射激波最强，缩放型喷管次之，匀直喷管最弱，因而采用收缩型喷管时的冷效应最强；最大制冷效率 η max 随相对充气时间 τ 的增加先增大后减小，在 ε =4、振荡管长径比 L/d=400、气体分配器喷射孔的相对深度为 0.55 的情况下，制冷机最佳相对充气时间约为 0.06；相对充气时间 τ <0.075 时，振荡管的最佳激励频率 fopt 为制冷效率曲线第二波峰的频率，τ >0.075 时则为制冷效率曲线第三波峰的频率。

关键词　压力波制冷机；实验验证；气体分配器；喷管；制冷效率

The Structure of Gas Distribution on the Flow in and the Performance of Pressure Wave Refrigerator

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Abstract　The influence of some structural factors, i.e. the nozzle style, relative gas charge time on the flow in and the performance of pressure wave refrigerator are analyzed theoretically and studied experimentally in this paper. The result show that the strength of incident shock wave is strongest when using the contraction nozzle, follows by using the laval nozzle, and is the weakest when using the uniform nozzle when the ratio of the expansion ε is form 2.0 to 12.0. Thus the cooling effect of pressure wave refrigerator is strongest when using the contraction nozzle. The maximun refrigerating efficiency ηmax is increased first increased and then decreased by the relative gas charge time τ increased. The optimum the relative gas charge time τ is 0.06 nearby when the ratio of the expansion ε is 4, the ratio of length to diameter L/d is 400 and the ralative depth of the jet hole in gas distribution is 0.55. When τ>0.075, the optimum pulsing frequency (fopt) is on the refrigerating efficiency of the second peak, but fopt is on the refrigerating efficiency of the third peak with τ>0.075.

Keywords　pressure wave refrigerator; validation; gas distribution; nozzle; refrigerating efficiency

无接触热阻全铝换热器空调系统制冷性能研究［刊，中］

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摘　要　本文用新型无接触热阻全铝换热器对传统家用空调换热器进行了替代设计，利用空气焓值法对使用新型换热器和管片式换热器的家用窗式空调器进行对比实验，优化并测试了毛细管规格和制冷剂充灌量对新型换热器空调系统制冷性能的影响。研究结果表明：新型无接触热阻全铝换热器在换热面积减小 37.53%时，制冷量反而提高 3.59%，能效比 EER 提高 7%。新型换

热器有更强的换热能力，是目前家用空调换热器的理想替代产品。

关键词 空调器；制冷性能；无接触热阻换热器；全铝换热器；实验研究

Cooling Performance of Air Conditioning Systems with Non-contact Thermal Resistance Aluminum Heat Exchanger

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Abstract   In order to replace the traditional heat exchanger of family air-condition, a new non-contact thermal resistance aluminum heat exchanger was designed. Enthalpy method is then used to do compare the cooling performance between new heat exchanger and tube-fin heat exchanger of household air conditioner. The capillary size and refrigerant charge capacity of air conditioner are tested and optimized for better cooling performance. The results show that the heat transfer area of the new non-contact thermal resistance aluminum heat exchanger is decreased 37.53%, the rated cooling capacity is just reduced by 2.7%, EER increased by 7% instead. The new heat exchanger has a stronger heat capacity and is the ideal alternative product for heat exchangers of room air conditioning.

Keywords   air conditioner; cooling performance; non-contact thermal resistance heat exchanger; experimental study

附加保温融霜装置的冷风机融霜实验研究［刊，中］

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摘 要   为了减小融霜热在融霜过程对冷库内温度变化的影响，对库内冷风机增设保温融霜装置，并进行了实验研究。结果表明保温融霜和非保温融霜两种过程，库内上方区域温度均有较大变化。保温融霜过程温度变化相对较小，其整体波动温差比非保温融霜低 3.2 ℃，且保温融霜方式的融霜时间缩短近 300 s；证明保温融霜装置在融霜过程中能够起到稳定库内温度和缩短融霜时间的作用。

关键词 热气融霜；保温融霜装置；温度场

Experimental Research on Defrosting Process of Cooling Fan with Heat Insulation Defrosting Device

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Abstract   In order to reduce the effect of defrosting heat in the process of cold storage defrosting temperature

change, a heat insulation defrosting device is additionally provided to the air cooler in the storage, and the experimental study was carried out. The results showed that in the defrosting processes with and without heat insulation, the temperature of the upper area in the storage changed greatly. The temperature changes relatively small during the heat defrosting process with heat insulation, and the overall fluctuate temperature range is 3.2 ℃ lower than that without heat insulation. In the meantime, the defrosting time with heat insulation is shortened by nearly 300 s, which proves that the insulation defrosting device can stabilize the storage temperature and shorten the defrosting time in the defrosting process.

Keywords hot gas defrosting; heat insulation defrosting device; temperature distribution

一种新型冷藏车箱体模型的设计与实验验证 [刊，中]

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摘　要 设计了一种具有蓄冷功能的冷藏车箱体模型。为了评估此箱体的保温功能，首先对其传热效果进行了三维数值模拟，然后以上海青为例对其进行了实验验证。结果表明，此冷藏箱体可以有效地减缓冷藏运输过程中上海青的温度回升速率，说明在冷藏车的箱体中添加复合相变材料可以提高其保冷效果。

关键词 冷藏车；蓄冷；数值模拟

Design and Experimental Verification of a New Type of Refrigerator Car Vehicle Model

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Abstract A new type of refrigeration cabinet with composite phase change material was designed in this paper. In order to assess the refrigerator heat preservation function. First of all, the three dimensional unsteady phase change heat transfer process with variable heat source was simulated and calculated by ANSYS software. Then the simulation results were verified experimentally with cold storage and transportation of Shanghaiqing(Brassicachinensis L.), The results showed that the temperature rise of Shanghaiqing inside the cabinet was delayed when the composite phase change materials was applied. So that adding composite phase change material can effectively improve the effect of the cold in refrigerated vechicle.

Keywords thermal engineering; refrigerated vehicle; cold storage; the numerical simulation

醇类保护剂对猪软骨低温膨胀过程的作用 [刊，中]

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摘　要　在对关节软骨进行低温保存时，常常会观察到低温断裂现象，然而其生物力学性能的低温损伤机理至今仍不甚明确。采用热机械分析仪，在0℃到－60℃的温度范围内，在不同慢速降温速率下，研究了四种醇类低温保护剂对猪关节软骨热膨胀行为的影响。结果表明：降温过程中，软骨细胞外存在的热膨胀现象，导致关节软骨产生了较大热应力；当添加浓度较高的乙醇和乙二醇时，降温速度越快，关节软骨产生的热应力越大，因而，降温速度越慢，越适合关节软骨的低温保存；而添加1,2-丙二醇和甘油时，则存在最佳降温速率(3℃/min)，最佳降温速率下的软骨产生的热应力最小。同时分析结果表明，四种醇类低温保护剂中，甲基化高的醇类保护剂的热膨胀保护效果更优。

关键词　低温保存；热应变；热机械分析仪；关节软骨；慢速降温

Effects of Cryoprotectant on Thermal Expansion of Articular Cartilage during Freezing Process

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Abstract　Low-temperature fracture is often observed during the low-temperature preservation of articular cartilage. However，the biomechanical damaging mechanism of cryopreservation is still unclear. During freezing from 0℃ to -60℃，Thermal Mechanical Analysis (TMA) was used to investigate the effects of 4 kinds of cryoprotecants with different concentrations. The results indicate that:（1）the cartilage produced a great thermal stress due to the extracellular thermal expansion during the cooling process；（2） when adding a higher concentration of ethanol and glycol，the faster the cooling rate，the greater thermal stress the articular cartilage will produce，and thus，slower cooling rate is more suitable for the cryopreservation of articular cartilage；（3） while adding 1, 2 - propylene and glycerin，there is an optimal cooling rate (3℃/min) and it produces cartilage a minimal thermal stress. Moreover，cryoprotectants of higher methylation will contribute better protective effect to the thermal expansion among the 4 kinds of alcohols.

Keywords　cryopreservation；thermal strain；thermal mechanical analyzer； articular cartilage；slow cooling rate