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Usmeritve v razvoju kompresorjev Trends in Compressor Development

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Izdelovalci kompresorjev z vsega sveta se soočajo s težavami. Proizvodnja kompresorjev se zmanjšuje. Pred vradi je leto 1996, ko bo prepovedana uporaba hladiv na podlagi klorofluor- ogljikov (CFC), kamor spadata tudi najpogosteje uporabljana R-12 in R-502. V predstavljenem zapisu smo analizirali svetovni trg hladilnih naprav ter posledice zaradi uvajanja novih vrst hladiv in novih konstrukcij v proizvodnji kompresorjev.

All compressor manufacturers in different parts of the world face difficulties. The production of compressors is falling. We are now approaching 1996, when the use of chlorofluorocarbons (CFC), including R-12 and R-502, will be prohibited. In this paper, the refrigeration market, and the introduction of new refrigerants and compressor types are discussed.

1 POSTOPNO ODPRAVLJANJE CFC

Do leta 1995 ali 1996, odvisno od držav, bo treba, zaradi škodljivosti za okolje, zamenjati hladivi R-12 in R-502 (CFC). Nadomestilo za obe omenjeni hladivi so mnogi izdelovalci našli v R-22 (HCFC), kar pa je pravzaprav le začasna rešitev, saj bo uporaba tudi tega hladiva dokončno prenehalila leta 2019, verjetno pa še prej [2]. Posebej v evropskih državah se že sedaj pojavlja močan odpor proti uporabi R-22 in prihajajo predlogi, da se rok za prepoved R-22 skrajša, oziroma naj se pospešijo raziskave, da bi našli ustreznejše nadomestno hladivo.

AREP (R-22 alternativni hladilni program) je obsežen projekt, s katerim naj bi poiskali primernejšo zamenjavo za R-22, pri katerem sodeluje 45 svetovnih izdelovalcev kompresorjev ter veliko opazovalcev petrokemijske industrije, univerz in raznih nadzornih organov. Projekt bo trajal do konca leta 1994; takrat bo tudi znano, kateri od 18 vrst testiranih hladiv lahko zamenja R-22.

Prehod na novo hladivo ne povzroča težav samo izdelovalcem hladilnih naprav, pač pa tudi njihovim uporabnikom. Odločiti se morajo med staro, preizkušeno tehnologijo ter novo, ki jo bosta država in družba podpirali in spodbujali, vendar še ni jasno, kdaj in kako uspešna bo.

Prvi iz serije novih hladiv je R-134a (HCF), ki se je uveljavil pri malih in srednjeverelikih hladilnih napravah. Serijska proizvodnja novih kompresorjev, ki uporabljo to hladivo, se je že začela. Za zdaj so to batni kompresorji, Melco pa je naredil tudi prvo rotacijsko izvedbo. Tudi v avtomobilskih klimatizirnih napravah se R-134a izredno hitro uveljavlja, vendar bo zamenjava trajala še vse leto 1994 in 1995, ker je število izdelovalcev tovrstnih kompresorjev majhno.

1 CFC PHASEOUT

By the year 1995 or 1996, depending on the country, R-12 and R-502 (CFC) must be phased out. R-22 (HCFC) is currently used as an alternative for both media. However, this is only a temporary solution, since R-22 is to be phased out by 2019, or perhaps even sooner [2]. In some European countries resistance against the use of R-22 has been appearing and there are suggestions that its use and production should be stopped in a shorter time, or that a better replacement for R-22 should be found.

AREP (R-22 Alternative Refrigerant Evaluation Program) is an extensive project which was started in order to find a suitable replacement for R-22. Some 45 compressor manufacturers are participating, as well as many observers from the petrochemical industry, universities and supervisory institutions. The project will terminate by the end of 1994, and when which of 18 types of refrigerant will replace R-22 will be known.

The transition to a new refrigerant has become a serious issue for compressor manufacturers and consumers. They have to decide whether to buy old, known technology or a new one sponsored and stimulated by the state and society, but they are not sure how good the new technology will be.

R-13-1a (HCF) is the first of the new refrigerant product-line. It is mostly used in small- and medium-size refrigerating equipment. Production has already started. The manufacturer basically developed refrigerators using reciprocating compressors; Melco developed the world's first R-134a refrigerators using rotary compressors. In automobile air conditioning system, R-134a units have become very popular. However, since compressor manufacturers are limited in number, the replacement will proceed in 1994 and 1995.

Obstajajo tudi druge rešitve. Nekaj nemških izdelovalcev je začelo izdelovati hladilne naprave, ki ne uporabljajo ne CFC ne HCFC pa tudi ne HFC, pač pa so uporabili ogljikovodike (CH), npr. propan in butan. Gre za majhne naprave, v majhnem številu, tako da je težko pričakovati, da bi ti poskusi lahko odprli novo smer v razvoju hladilnih naprav.

Vse bolj se uveljavlja tudi amonijak, posebej v Evropi. Amonijak ima nesporo dobre lastnosti za uporabo v hladilstvu; vendar je zaradi toksičnosti težko napovedati njegovo uveljavljanje.

2 TRŽNA ANALIZA

Tržne raziskave kažejo, da potrebujemo okoli 66 do 69 milijonov kompresorjev na leto za hlajenje v gospodinjstvu; zmogljivosti svetovnih izdelovalcev pa so za okoli 10 milijonov enot večje [4]. Zato lahko pričakujemo še nadaljnje zniževanje cen in trdo borbo za porabnika. Ker se približuje leto 1996, ko bo treba nadomestiti R-12 v gospodinjskih aparatih, so vsi večji izdelovalci že poslali na trg nove kompresorje z nadomestnim hladivom R-134a. Prihodnost posameznih izdelovalcev je v veliki meri odvisna od tega, kako uspešno je bila nova tehnologija R-134a sprejeta, oziroma kakšno mesto na trgu si bo izdelovalec z novimi izdelki pridobil.

Podobna razmerja vladajo tudi na trgu manjših in večjih sobnih klimatizirnih naprav (RAC/PAC). Trg potrebuje okoli 23 milijonov naprav na leto, zmogljivosti pa so precej večje [4]. Razen v ZDA, kjer izdelovalci batnih kompresorjev trdno drže položaje v rokah, predvsem zaradi razvijane prodajno-servisne mreže, izboljšane kakovosti in nizke cene, se batni kompresorji, ki so sicer še pred kratkim popolnoma obvladovali to področje, umikajo rotacijskim. V zadnjem času so posebej uspešne naprave s spiralnimi kompresorji.

V napravah za pripravo hladilne vode se v manjših enotah uporabljajo batni kompresorji, pri večjih pa centrifugalni in vijačni. Največji problem so centrifugalni kompresorji v velikih klimatskih napravah. Večina jih je nameščena v ZDA, velik del jih je treba, zaradi škodljivosti za okolje, zamenjati oziroma preureediti. To pomeni sicer ogromen strošek, na drugi strani pa je to izliv za vse izdelovalce, da predstavijo lastno, manj škodljivo tehnologijo. Potreba po centrifugalkih hladilnih agregatih se hitro zmanjšuje, hkrati pa narašča proizvodnja absorpcijskih hladilnih naprav, ki naj bi po napovedih zamenjale centrifugalne enote [3].

3 VRSTE KOMPRESORJEV

Prvi serijsko izdelani kompresorji so bili batni. V skladu z razvojem industrije so se širili po vsem svetu, tako da jih v eni ali drugi obliki lahko

There are also some other solutions. A few German manufacturers have produced refrigerators which use neither CFC and HCFC nor HCF, but use hydrocarbons (CH), such as butane and propane. The refrigerant capacity is small, as is the number of units produced, so it can not be expected that these experiments could set a new direction in refrigeration.

In Europe, manufacturers are beginning to recognize the effectiveness of ammonia. Although ammonia excels in performance characteristics as a refrigerant, it is hard to anticipate how it will be implemented, because of its toxicity.

2 MARKET ANALYSIS

According to market analysis, the world demand for household refrigeration is said to be about 66 - 69 million units per year, while production capacity is about 10 million more [4]. We may expect prices to decrease in the future and a severe fight for customers on the market. Because of CFC phaseout, the major manufacturers have started producing R-134a compressors. The future of each manufacturer will be affected by the extent to which its R-134a technology is successfully developed and what place in market the manufacturer gains.

Similar relations govern the market for room air conditioners (RAC) and packaged air conditioners (PAC). The world demand is 23 million units per year, while production capacity is far more [4]. Except in the USA, where reciprocating compressors manufacturers still hold their positions on the market through established sales/service networks, improved efficiency and low prices, reciprocating compressors, the most common compressor type in the past, have been widely replaced by rotating ones. Recently the scroll compressors in PACs are becoming very popular.

The reciprocating type is employed in small chillers, and the centrifugal and screw type in large chillers. Large centrifugal compressors represent the greatest problem. Most centrifugal units are installed in the USA, and many of them must be replaced or retrofitted, because of damage to the environment. The cost will be enormous, but on the other hand, this is a challenge for the manufacturers to present their own harmless technology. The demand for centrifugal chiller units is falling sharply, and production of the absorption type, which seems set to replace the centrifugal type, is growing quickly [3].

3 COMPRESSOR TYPE

The first mass manufactured compressors were reciprocating. According to industry development, this type of compressors has diffused throughout the world, and today it can be found

najdemo kjer koli po svetu. Kljub vse večjemu pritisku po vkjučevanju rotacijske tehnologije, batni kompresorji še ne bodo izgubili pomena, ki ga imajo, rešiti pa bo treba dva kjučna problema — prvič: problem prepovedi uporabe hladiv, ki vsebujejo CFC, in drugič: izboljšati izkoristek. V gospodinjskih hladilnih napravah prevladujejo hermetični batni kompresorji že od 50. let, ko so bili razviti. S povečanimi zahtevami po ugodju so se v povečanih izvedbah preselili v sobne klimatske naprave (RAC). V ZDA in Evropi imamo precejšnje število izdelovalcev kakovostnih batnih kompresorjev, npr.: Tecumseh, Copeland, Bristol, York, Carrier, Danfoss, Elektrolux, Aspera, Dorin, Bock. Maneurop še danes izdeluje hermetične kompresorje od 1 kW do 22,5 kW, čeprav se za moči, večje od 10 kW običajno uporablja polhermetična oziroma odprta izvedba. Glede na veliko število prodanih izdelkov in dobro vpeljano tehnologijo, razvijano prodajno-servisno mrežo ter ugodno ceno lahko pričakujemo, da do zatona batnih kompresorjev še ne bo prišlo. Zaradi velikih presežkov pri drugih vrstah konstrukcij, pričakujemo zmanjšanje proizvodnje, predvsem večjih moči.

Razvoj vijačnih kompresorjev se je začel v poznih 50. letih. Zaradi velikega izkoristka, dobre regulacije ter vzdržljivosti se njihovo področje uporabe širi. Izdelujejo jih v močeh od nekaj kW pa do 1000 kW. Kljub višji ceni vztrajno odvzemajo trg batnim, skoraj popolnoma pa so izpodrinili centrifugalne. Pred leti, ko so na novo oblikovali rotor in stator dvojnega vijačnega kompresorja, so dosegli boljši izkoristek in povečali zanimanje za tovrstno konstrukcijo. Pričakuje se povečanje proizvodnje, posebej sedaj ko so prišli na trg veliki izdelovalci iz ZDA, npr. Carrier, Trane in SG.

Razvoj rotacijskih kompresorjev se je začel v ZDA, najbolj pa so se uveljavili na Japonskem, kjer se je serijska proizvodnja začela leta 1967. Glavne prednosti rotacijskih kompresorjev so večji izkoristek, manjša teža ter manjše število delov. Uporabljajo se predvsem za manjše in večje sobne klimatizacijske naprave (RAC/PAC), na Japonskem pa pokrivajo tudi že 30 odstotkov tržišča gospodinjskih hladilnih aparativ. Glavni izdelovalci so na Japonskem, v ZDA ter v vzhodni Aziji.

Leta 1981 je japonsko podjetje Sanden predstavilo prvi serijski spiralni kompresor, namenjen za uporabo v avtomobilski klimatizirni napravi. Hitachi pa je leta 1983 začel s serijsko proizvodnjo spiralnih kompresorjev za toplotne črpalke in klimatizacijske naprave. V ZDA se je to zgodilo leta 1987, ko je Copeland predstavil svojo konstrukcijo prilagodljivega spiralnega kompresorja z imenom ZR1. Ta kompresor je bil rezultat dvanajstletnega dela velikega štivila strokovnjakov, ki so pri iskanju konstrukcije preizkusili skoraj 500 prototipov

all over the world. Despite rotary technology, the reciprocating type will not lose its role on the market. However, two major problems must be solved: first, the urgent need to solve the CFC problem and second, the demand for higher efficiency. In the sphere of household refrigerators, the reciprocating type has dominated since the 1950s, when it was developed. Thereafter, this type spread into the RAC market. In the USA and Europe there are many high-quality reciprocating manufacturers: Tecumseh, Copeland, Bristol, York, Carrier, Danfoss, Elektrolux, Aspera, Dorin, Bock. Maneurop offers a hermetic reciprocating series from 1 kW up to 22.5 kW, although the semihermetic or open type has occupied the class larger than 10 kW. With regard to the largest cumulative installations and well-established technology, widened sales/service network and satisfactory prices, we can expect that reciprocating compressors will not be on the wane very soon. Because of a surplus of other types of compressors, it can be expected that production will decrease, especially for large compressors.

The development of screw compressors began in the late '50 s. Because of high efficiency, smooth response to capacity changes and maintainability, their range of application is still growing. They are produced from some kW to about 1000 kW. Even though the price is higher they, are persistently taking market share from reciprocating compressors, and they are almost entirely supplanting centrifugals. A few years ago, when the twin rotor configuration was redesigned, better efficiency was achieved and interest in new design was enhanced. Production capacity will increase, because many major manufacturers from USA, such as Carrier, Trane and SG have entered the market.

Rotary compressors were developed in the USA. But it was in Japan, where production began in 1967, that they first became widely accepted. Their advantage is they are more efficient, lighter and have fewer parts than conventional reciprocating compressors. They are generally used for RAC and PAC, but in Japan rotary compressors are installed today in about 30 % of household refrigerators. The world's largest manufacturers are Japan, the USA and East Asia.

In 1981, Sanden introduced the first serial scroll compressor for car A/C use. Hitachi began production of scroll compressors for PAC and heat pumps in 1983. In USA, Copeland first started production in 1987 with the compliant scroll compressor ZR1. ZR1 was the result of twelve years work by many experts, who tested almost 500 prototypes when searching for the right design [1]. Today Copeland is the leading manufacturer

[1]. Zdaj je Copeland vodilni izdelovalec spiralnih kompresorjev v svetu in jih letno izdela okoli dva milijona.

Tretja generacija njihovih kompresorjev se imenuje ZR3. Imajo velik izkoristek ter majhno šumnost; izdelujejo pa jih v seriji od 1 kW do 18 kW. Pomembni izdelovalci v ZDA so še Trane, Carrier in Tecumseh. Na Japonskem imamo sedaj osem izdelovalcev spiralnih kompresorjev. Med njimi najdemo vse velike izdelovalce, npr.: Matsushita, Melco, Daikin, Toshiba, Hitachi, Sanyo in MHI.

V Evropi je podjetje Maneurop v letu 1992 dala na tržišče serijo spiralnih kompresorjev, ki so nastali po licenci podjetja Trane, Copeland pa pripravlja proizvodnjo v Belgiji, ki bo predvidoma stekla 1994.

Spiralni kompresorji se vgrajujejo predvsem v manjše in večje sobne klimatske naprave ter toplotne črpalki. Predvidoma se bo proizvodnja še povečevala, odvisna pa bo predvsem od poslovnega stanja na trgu sobnih klimatizacijskih naprav.

4 SKLEP

Težave izdelovalcev hladilne opreme izhajajo iz vsesplošne svetovne recesije in prehoda na nova, okolju prijazna hladiva. Z izjemo Kitajske, ki zaradi razvijajočega se tržišča, povečuje proizvodnjo kompresorjev in pričakuje še nadaljnjo strmo rast, se vsi drugi soočajo s padcem prodaje in izvoza. Zaradi težke situacije na trgu ter visokih stroškov za razvoj nove tehnologije in produktov so izdelovalci prisiljeni sodelovati med seboj; tako iz nekdanjih tekmecev postajajo bodoči zavezniki.

in the world, producing approximately 2 million units/year.

The third generation, called ZR3, achieves high efficiency and low noise, ranging from 1 kW to 18 kW. Important manufacturers in the USA are Trane, Carrier and Tecumseh. In Japan there are eight scroll compressor manufacturers. Among them we can find all major manufacturers: Matsushita, Melco, Daikin, Toshiba, Hitachi, Sanyo and MHI.

In Europe, Maneurop in 1992 started manufacturing a series of scroll compressors under licence from Trane and Copeland is preparing scroll production lines in Belgium, which should start in 1994.

Scroll compressors are conventionally incorporated in RAC/PAC and heat pumps. Most probably, production will steadily increase, but it will be affected by the business situation on the RAC/PAC world market.

4 CONCLUSION

The difficulties of refrigeration equipment manufacturers originate from worldwide recession and the transition to the new, environment-friendly refrigerants. With the exception of China, which is expanding its production of compressors and expects even further steep growth because of its developing market, countries are confronted with falling of sales and exports. Because of the severe market situation and the high costs for the development of new technology and products, the manufacturers are forced to cooperate; so, from former competitors, future allies are growing.

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