Assuring reliability of compressor using HFC refrigerant

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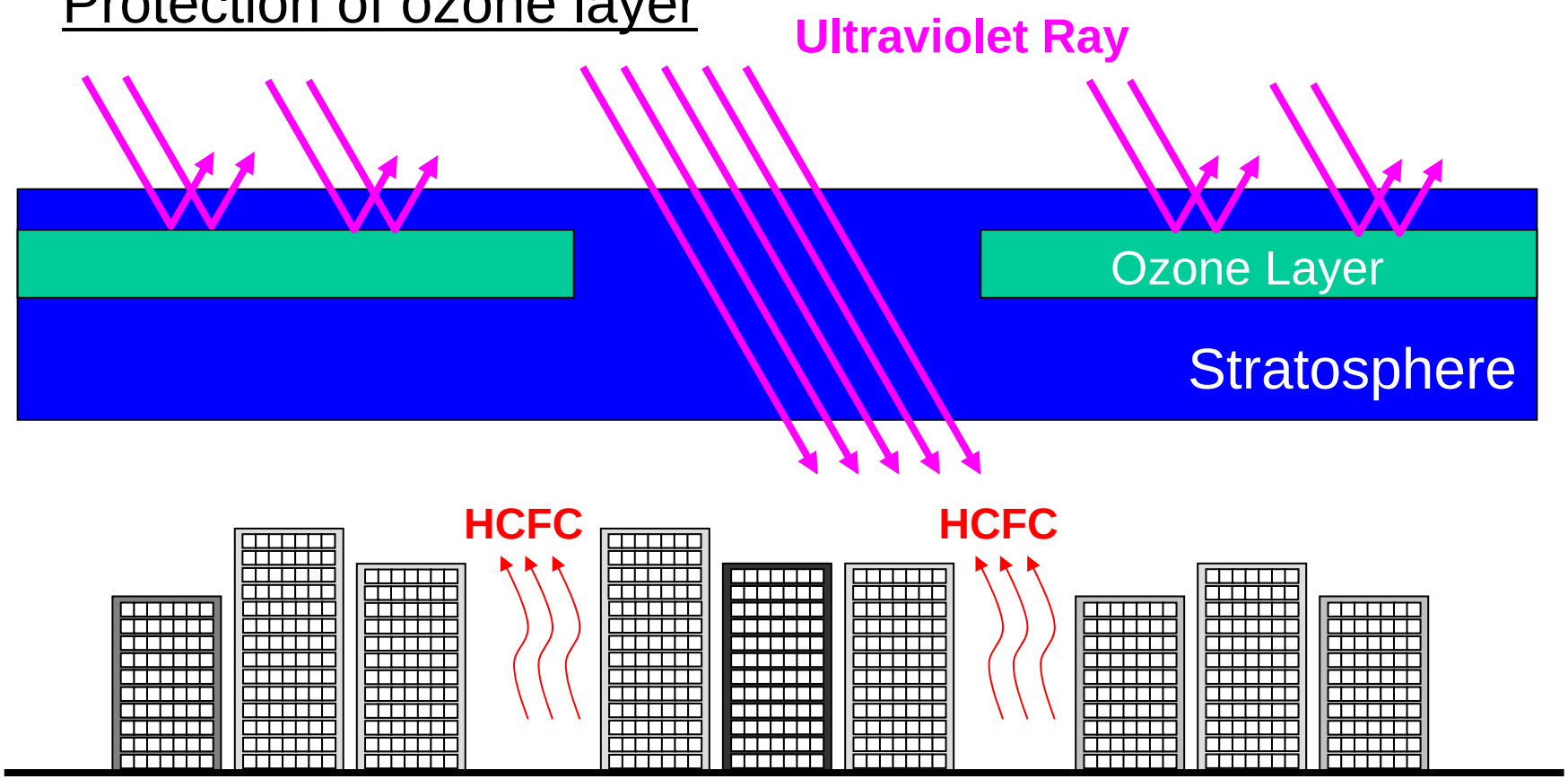
Introduction

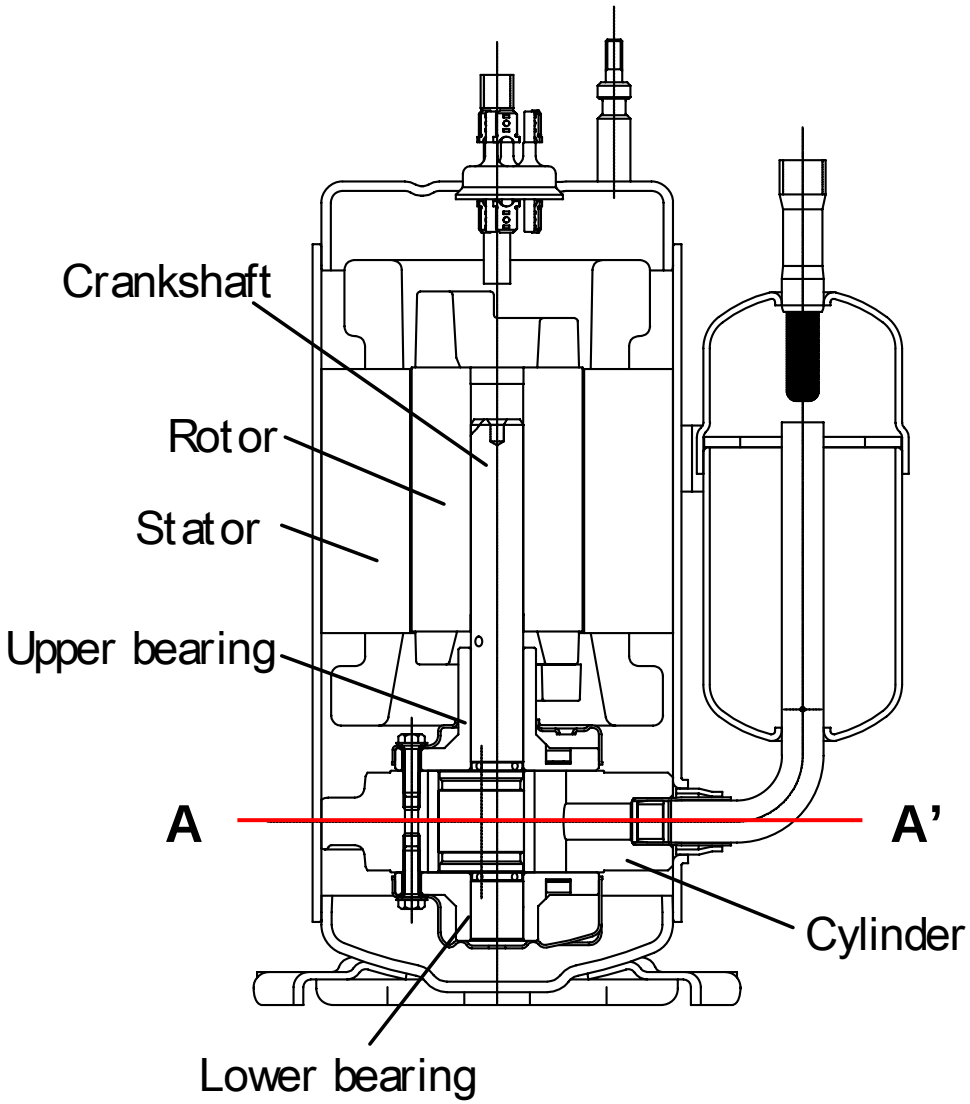
Protection of ozone layer

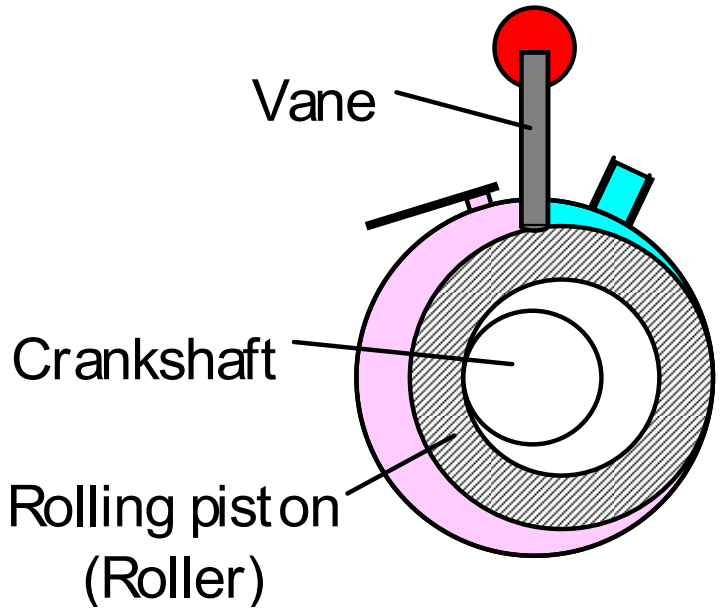


$Cl + O_3 \rightarrow ClO + O_2$

$C\,l + O + O \rightarrow Cl + O_2$

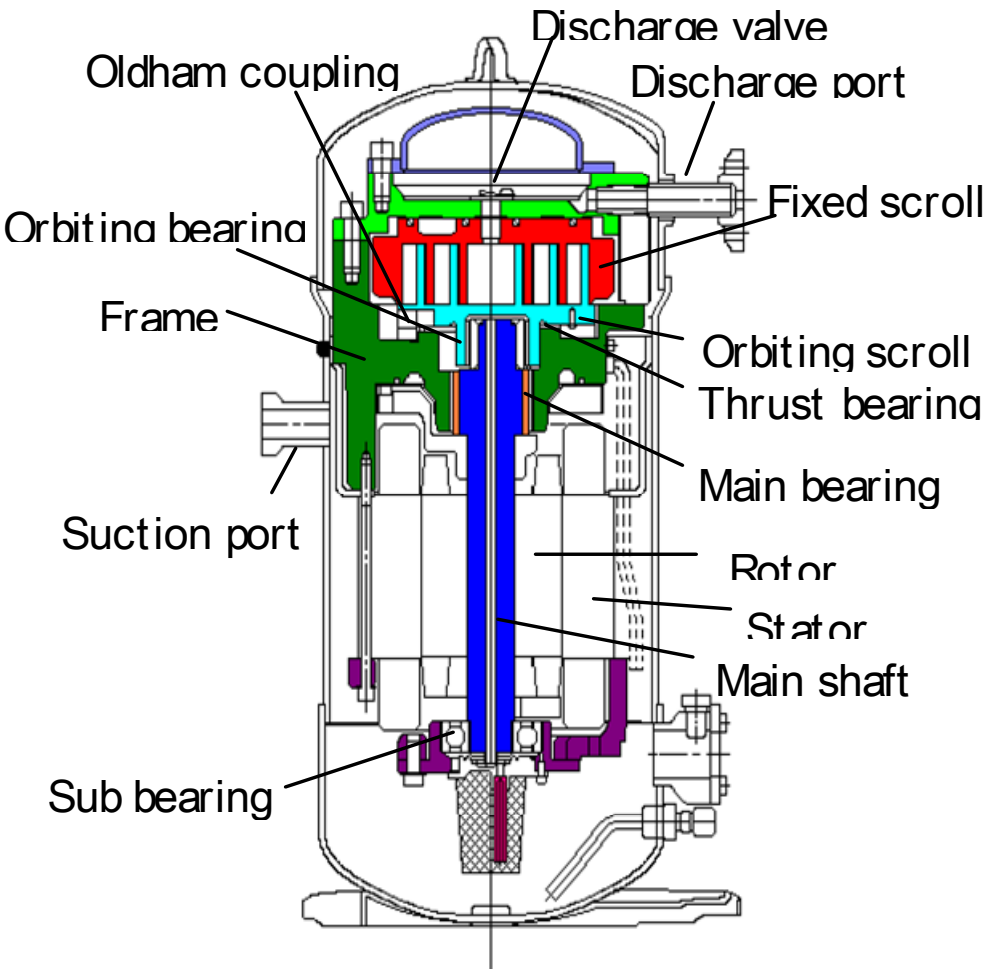
Cross-section View of Rotary Compressor

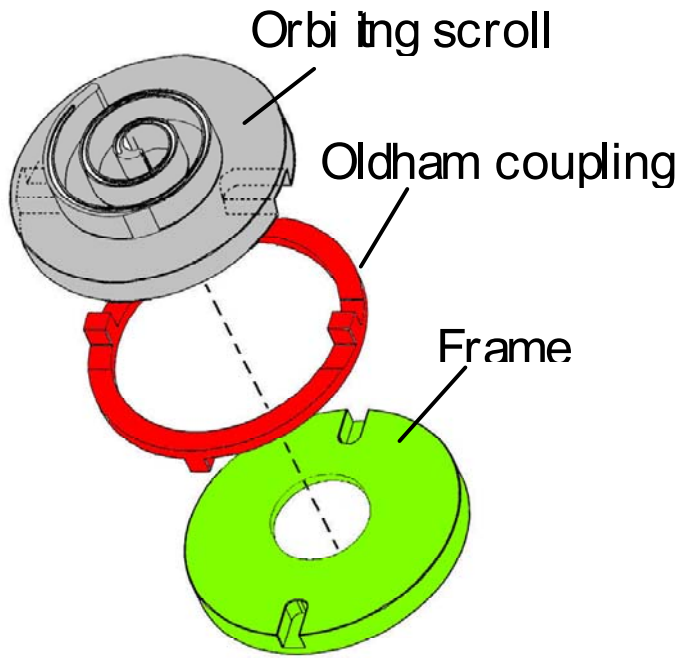




Cross-section view of A-A'

Cross-section View of Scroll Compressor





Characteristics of Refrigerants

refrigerant	HCFC	HFC
	R-22	R-410A
components	-----	HFC-32/125
(ratio, wt%)	-----	(50/50)
zeotropic /azeotropic	single	near azeotropic
ODP	0.055	0
GWP (100 years)	1700	1700
condensation pressure, MPa (40)	1.53	2.41

Refrigeration Oils

Refrigeration Oil	Miscibility with HFC	Application
Mineral oil	Low miscible	Refrigeration oil for HCFC
Ester oil	Miscible	Refrigeration oil for HFC
Ether oil	Miscible	
Alkyl benzene	Low miscible	Partial refrigeration oil for HFC

Ester and ether oils and alkyl benzene are synthetic oils.

Manufacturing Cost Increasing of Compressor

Compressor	1HP air-conditioning
Quantity of refrigerant	1 kg ($10)
	R-22→R-410A
Quantity of refrigeration oil	0.5 L ($2)
	Mineral oil → Synthetic oils
Price increasing (R22→R410A)	$12

The other cost increasing items are enhancing pressure tightness of shell and using surface treatments and alternative materials for the sectional sliding parts.
These costs are changed by design of compressor.

Considerations for Using of R-410A

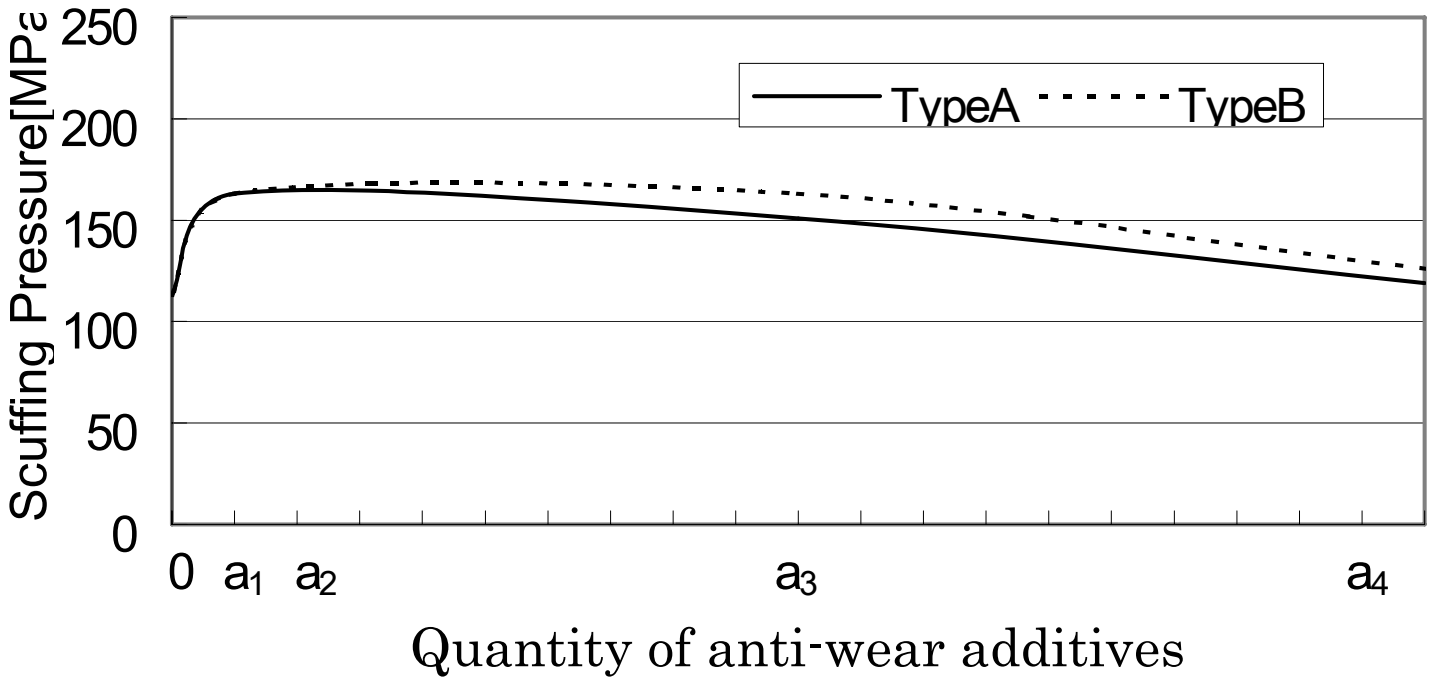
Reducing the quantity of water in the refrigeration oil.

Preventing the refrigeration oil deteriorating.

Preventing contaminants (e.g. chlorine including process oil) being mixed into the compressor.

Preventing the sludge generation.

Effects of Anti-wear Additives in Refrigeration Oil

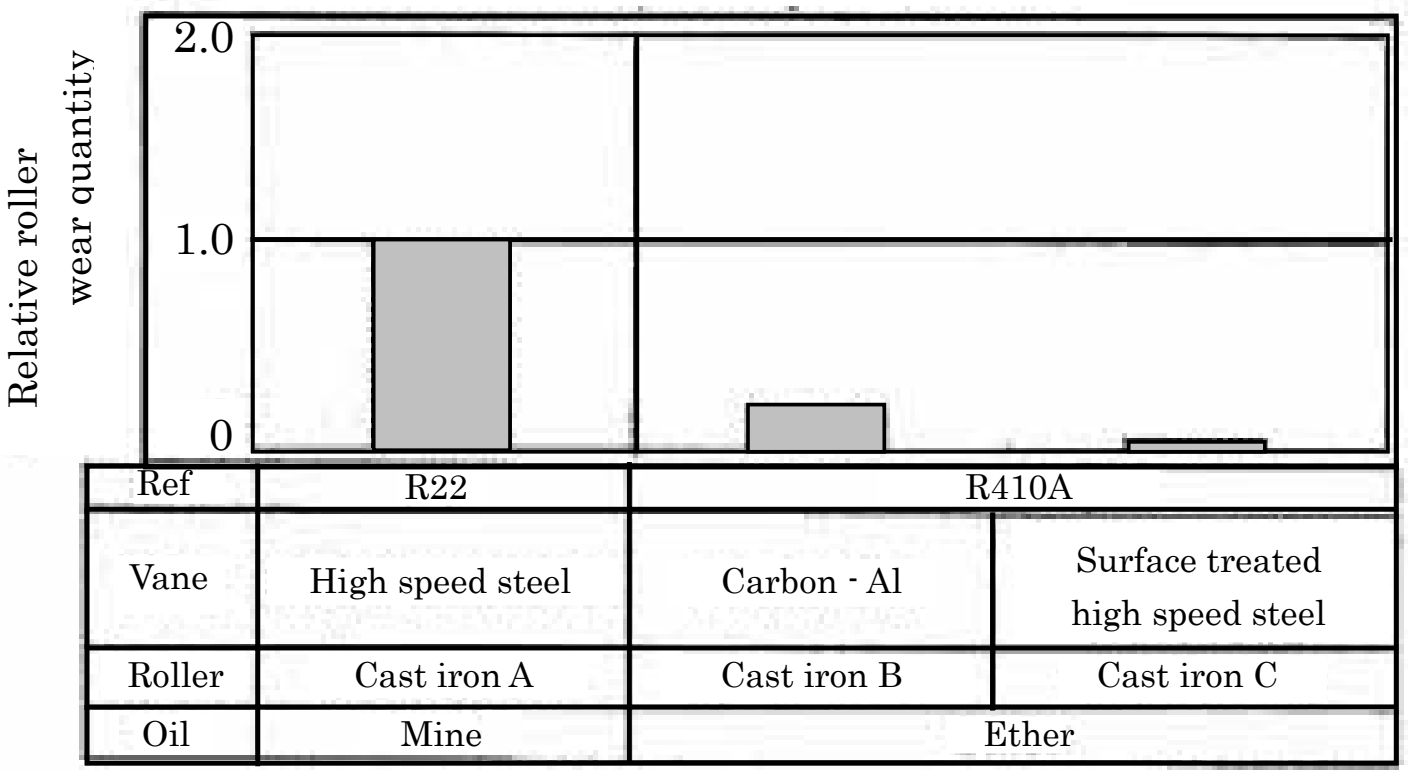


Relationship between quantities of anti-wear additives and scuffing pressure

When the optimum quantities of additives are added to the refrigeration oil, the scuffing pressure reaches the highest value.

Wear Amount of Vane and Piston (Roller)

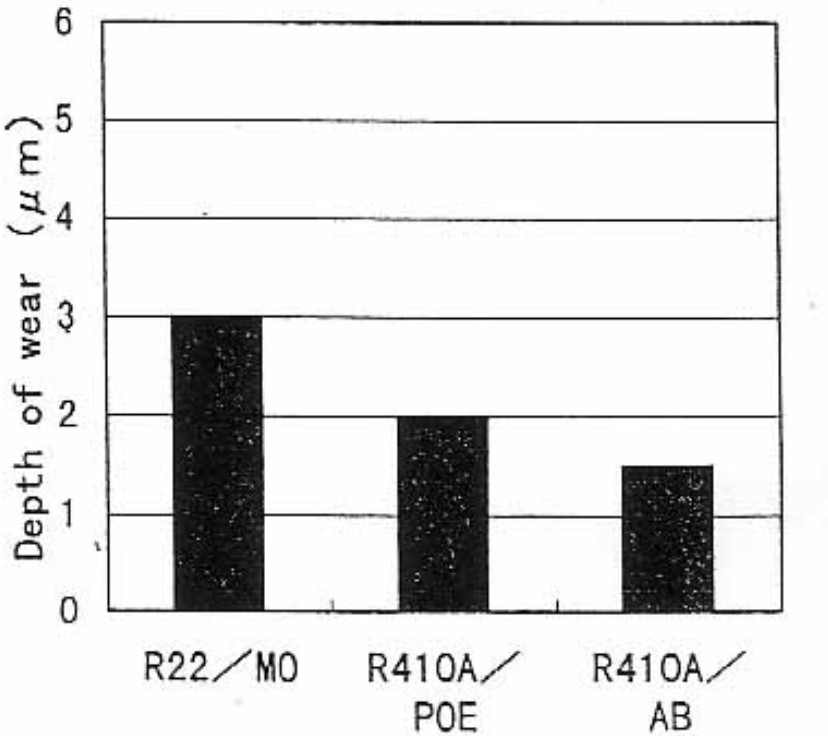
・Operating time：1000hs
・Inverter frequency：100Hz



Comparison of roller wear

When surface treated high speed steel is used for the vane, the amount of wear of the roller is reduced.

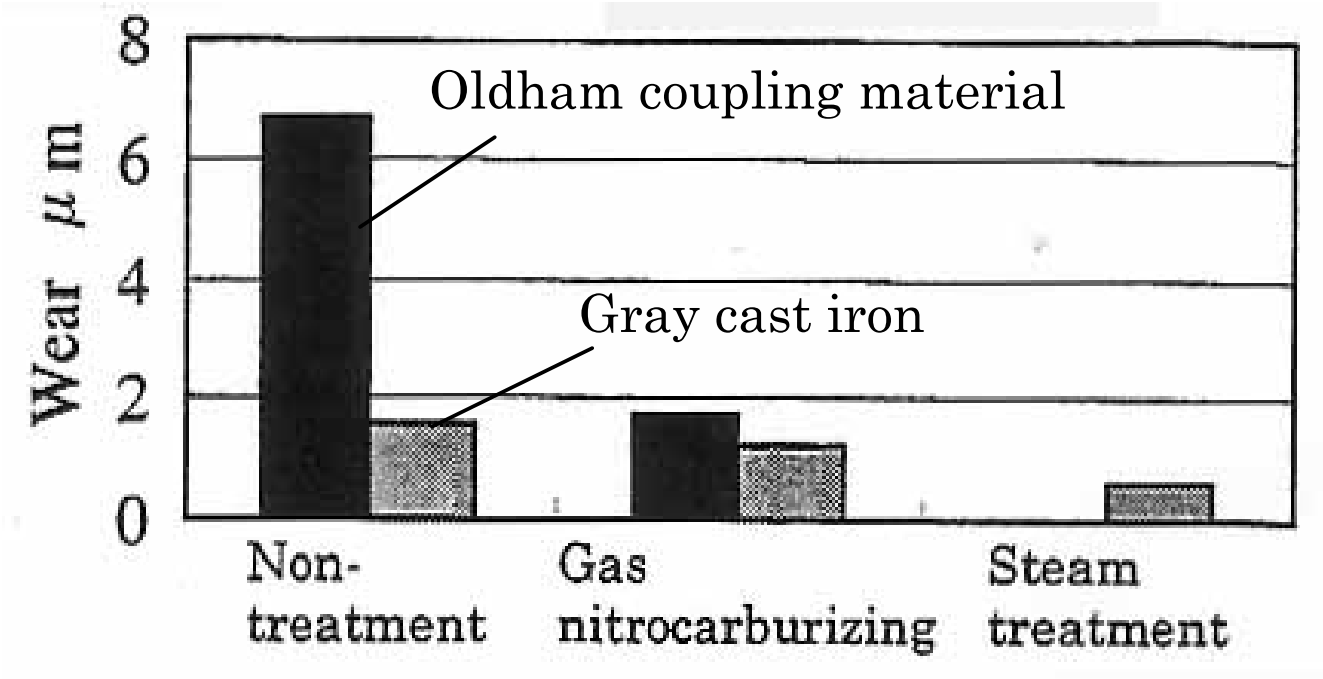
Wear Depth Using Alkyl Benzene for Refrigeration Oil



Wear depth of shaft after flooded-start test of rotary compressor

The wear depth using alkyl benzene is less.
A special oil returning mechanism is needed.

Wear Amount of Oldham Coupling



Wear amounts of Oldham coupling

When sintered iron is surface treated, the amounts of wear are reduced.

Summary

(1) The manufacturing costs increase when changing the refrigerant from HCFC to HFC.

- The refrigeration oils are changed from mineral oil to ester and ether oils (synthetic oils).
- Surface treatments and alternative materials are used for the sectional sliding parts.
- Pressure tightness of shell is enhanced, because acting pressure of R-410A is higher than HCFC.

(2) The performance of room air-conditioners using R-410A are better than those using R-22.

(3) The running costs, for example electricity, are the same.

In Japan including room air-conditioners, packaged air-conditioners and multi air-conditioners for buildings, and refrigeration machines all use HFC refrigerants.