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# SCIENTIFIC AND RELIGIOUS CONSIDERATIONS ON THE PROTECTIVE ROLE OF THE OZONE LAYER

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## Abstract

Science and religion have been placed on antagonistic positions for centuries. The Holy Quran is the Book which has numerous verses with scientific implications, proven in our modern times. One example is the ozone layer subject, which is described as a protecting and elevated roof, provided as a shield against the harm from space (the harmful ultraviolet rays emitted by the Sun).

Earth's ozone layer has been damaged by chemicals, among them CFCs and HCFCs used in marine refrigeration. International efforts focused on the phase out of these chemicals led to measures aiming the stratospheric ozone layer protection from much higher depletion. Centuries after the revelation of the Quran was demonstrated a fact stated in some Noble Verses: the ozone layer is able to heal itself.

This paper deals with the use of ammonia in refrigeration on board the ships. Ammonia is not a contributor to ozone depletion or global warming, being considered biodegradable. As shown in this study ammonia has superior thermo-physical properties and results to be a high COP (Coefficient of Performance) refrigerant.

*Keywords:* ozone layer, ammonia, refrigeration, verse

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## 1. Introduction

In our modern times of scientific development, unconditionally faith is no longer acceptable. Despite this, man is aware that he is an extraordinary creation, for its existence being 'responsible' the Divine Being, which is called even by atheists in difficult times of their life. The Holy Quran is the Holy Book of the Muslims which is seen as 'a guidance to men' through convincing arguments. The revealed word of God contains a comprehensive religions philosophy, describing law and commandments, codes for social and moral behaviour of Muslims all over the world.

Muslims eat only foods that are 'Halal', an Arabic word meaning 'permissible'. At the end of the annual pilgrimage to Mecca (Hajj), Muslims throughout the world celebrate the Festival of Sacrifice, known as Eid al-Adha. During this holy celebration, Muslims honour Abraham's trials by slaughtering

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(Dhabiha) an animal, still alive, type sheep, cow, camel or goat. The resulted meat have several destinations: one-third is eaten by immediate family and relatives, one-third is offered to friends and neighbours and one-third is donated to poor. The meat from the sacrifice of Eid al-Adha is shared during the holiday (four days) or shortly after. But are needed arrangements to be done that this meat is not wasted. Nowadays, this meat is sent directly from Mecca to the needy people even far away, thanks to refrigeration.

Maritime transport is the most inexpensive mean of modern transport [1]. The Holy Quran states that Allah has provided mankind with a precious benefit, the seas: "... and the ships that run in the sea with that which profits man" (2:164). It should be interpreted in the way that ships should be used to establish connections between separated land masses and to eliminate racial differences. Nowadays, international trade and commerce strongly depends on sea transportation.

A significant environmental problem in connection with refrigeration is expressed by the ozone depletion in the stratosphere. In the following parts of this study is discussed the issue of refrigerated transport, the environmental aspect of this activity being addressed from scientific, but also religious point of view.

## **2. Considerations on the Earth's ozone layer**

The ozone layer is the Earth's ultraviolet shield. This layer is located in the lower portion of the stratosphere from about 20 to 30 kilometres above Earth and absorbs 97–99% of the Sun's high frequency ultraviolet light. It is composed of oxygen molecules and has a blue tend. One of the candidates for the thinning of the ozone layer are the CFCs (chlorofluorocarbons), chemicals used in older refrigerators that have been in production for more than a half century. CFC refrigerants contain chlorine, have a long lifetime and do not wash away in rain [2]. Thus, CFCs rise up into the ozone layer where they eventually break down due to exposure to ultraviolet radiation. As they decompose, these refrigerants release chlorine into the ozone layer, causing its depletion. Scientific evidence connecting CFCs and HCFCs to ozone depletion led to international regulations aiming the control of these chemicals [3]. These families of refrigerants were commonly used in marine refrigeration.

### **2.1. Religious aspects**

It is assumed that in the Noble Verse 21:32, Allah Almighty said that the ozone layer protects the Earth: "We made the sky a preserved and protecting roof yet still they turn away from Our Signs". Other related proofs are found in the Noble Book [4, 5]: Allah Almighty called our sky a lifted ceiling, an elevated roof (Sher Ali: 052:005), or "Don't you see how He created seven heavens in layers?" (71:15) and "He erected heaven and established the balance" (55:7). These verses might be also related also to the ozone layer and to its thickness:

- if this was any greater, the Earth’s temperature would fall dramatically,
- if this was any less, the Earth would overheat and remain entirely exposed to the harmful ultraviolet rays emitted by the Sun.

Also, the following verse refers to the ‘protective’ nature of the sky: “We tried, as usual, to travel to heaven in search of news but found it filled with fierce guards and meteors” (Surat al-Jinn, 8). Many recent interpretation assimilate the ‘guards’ identified in the sky with the ozone layer.

The protective feature of the ozone layer against the Sun’s harmful rays is also stated in the Noble Verse 18:90: “... he found it rising on a people for whom We had provided no shield against it the sun”.

This statement suggests that the ‘shield’ is able to protect from the harm coming from the sun (ultraviolet rays). Also, “We had provided no shield” means that the mentioned shield is natural, a God’s creation and not a regular handmade roof. It is also obvious from the above verse that there are places where people are not shielded. This fact was demonstrated only in our modern days, by satellites able to detect the holes in the ozone layer.

The Noble Quran states that the ozone layer is able to heal itself. This fact is confirmed by modern science. Scientists imposed the banning of Ozone Depleting Substances (like CFCs and HCFCs used in refrigeration) and proposed substitutes, friendly with the ozone layer, in order to permit the restoration of this layer.

Next, we are presenting a case of study from which results that ammonia can replace HCFC 22 in future refrigerating plants on board of ships.

## **2.2. Scientific aspects**

Because of the destructive effect of CFCs and HCFCs on the Earth’s stratospheric ozone layer, the international community has decided to reduce and eliminate their production. Starting with the mid of 80’s, in the refrigerated sector was registered a transition from CFCs to HCFCs and later to HFCs (hydrofluorocarbons), which are chlorine free refrigerants [6].

Table 1 gives values for the effect on the ozone layer of some common used refrigerants in marine transportation, measured by ODP (Ozone Depletion Potential) [7].

**Table 1.** The impact of some refrigerant on the ozone layer.

<b>Family of refrigerant</b>	<b>Refrigerant</b>	<b>ODP</b>
CFCs	CFC 11	1
	CFC 12	1
HCFCs	HCFC 22	0.05
HFCs	HFC 134 a	0
	HFC 404 A	
	HFC 407 A	
	HFC 410 A	
Natural refrigerants	R 717 (ammonia)	0

The trend in marine refrigeration indicates towards the use of HFCs or ammonia instead of CFCs and HCFCs. But the HFCs are potent green house gases with high global warming potential, while ammonia has a zero global warming potential (see Table 2 [8]).

This is why in the following section it is compared HCFC 22 (the refrigerant mainly used on refrigerated ships) with ammonia; both refrigerants work in a vapour compression cycle (the systems for refrigerated transport operating under this technology).

**Table 2.** Overview on the impact on global warming.

Family of refrigerant	Refrigerant	GWP (Global Warming Potential)
CFCs	CFC 11	4750
	CFC 12	10890
HCFCs	HCFC 22	1810
HFCs	HFC 134 a	1430
	HFC 404 A	3900
	HFC 410 A	2100
Natural refrigerants	R 717 (ammonia)	0

### 2.3. Study case

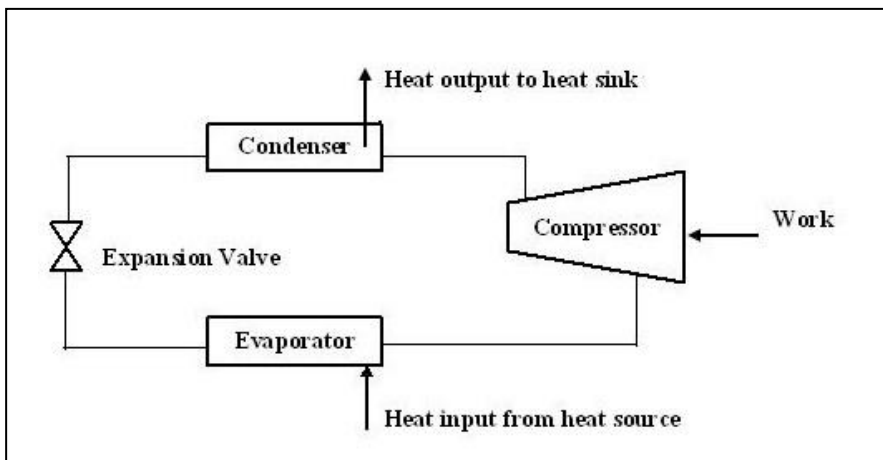
Ammonia refrigeration is the backbone of the food industry, a sector strongly dependent by transportation, since a significant amount of food that we buy daily is imported. We are fortunate to have the opportunity to consume food from all over the world, but we don't think too much that food arrives to us transported by different means (sea transportation being the most convenient). In doing so, we are impacting seriously the environment. The demand of halal food is increasing together with the growth of the Muslim population worldwide. Slaughtering is the primary stage in producing halal meat. Even if it has never been measured, the halal food market is estimated to several hundred billion USD/year [9]. Some Christian countries, such as Australia, New Zealand and Canada have implemented a slaughter system in accordance with Islamic law and ensure that the produced halal meat is now distributed throughout the world overseas.

Ammonia presents superior properties relative to HCFC 22, which made it a choice for vapour compression cycles [10]. These cycles take advantage of the fact that highly compressed fluids at a certain temperature tend to get colder when they are allowed to expand [11]. The components of such a system and the working cycle are given in Figure 1 and respectively in Figure 2.

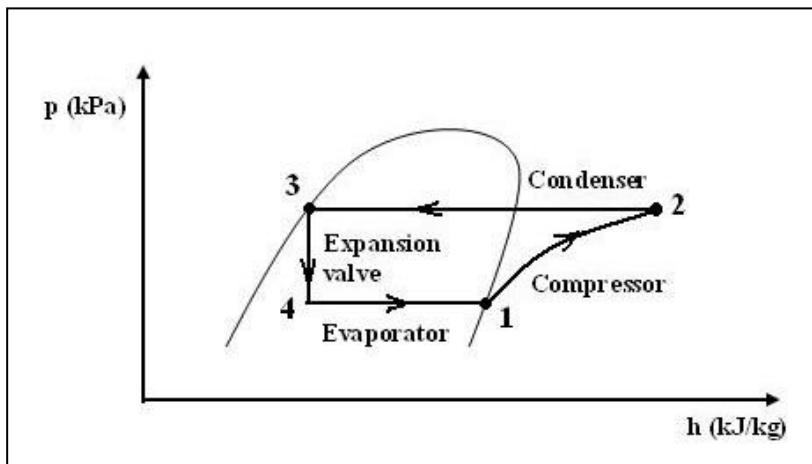
Low pressure liquid refrigerant absorbs in the evaporator heat from its surroundings. During this process it turns from liquid to gas. Resulted vapours enter in the compressor where their pressure is raised. Also their temperature increases, because a portion of the energy put into the compression process is

transferred to the refrigerant. The high pressure superheated gas passes from the compressor into the condenser where is de-superheated and after that is turned into liquid. A further reduction in temperature happens in the pipe work and liquid receiver, so that the liquid refrigerant is sub-cooled as it enters the expansion device. The high-pressure sub-cooled liquid passes through the expansion device, which both reduces its pressure and controls the flow into the evaporator. The Coefficient of Performance of the plant is given by the formula [12]:

$$\text{COP} = \frac{\text{Cooling effect (kW)}}{\text{Power input to compressor (kW)}} \quad (1)$$



**Figure 1.** Typical single stage vapor compression refrigeration.



**Figure 2.** Vapor compression refrigeration cycle.

In the next part of the study are given values for thermo-physical properties of ammonia and HCFC22, which is subject to the Montreal Protocol and its subsequent amendments. A comparison will reveal encouraging information together with data referring to the cycle efficiency.

### 3. Results and discussions

As a refrigerant, ammonia offers many advantages: favourable physical properties (see Table 3), similar pressure level compared to HCFC 22, but better thermal properties (see Tables 4, 5). It has very good cycle efficiency (see Tables 6, 7).

**Table 3.** Properties of ammonia at  $-10^{\circ}\text{C}$  and 101.325 kPa.

Boiling Point ( $^{\circ}\text{C}$ )	Freezing Point ( $^{\circ}\text{C}$ )	Vapor Pressure (kPa)	Vapor Volume ( $\text{m}^3/\text{kg}$ )	Liquid Enthalpy (kJ/kg)	Vapor Enthalpy (kJ/kg)
-33	-78	2.9	0.419	808.71	487.77

**Table 4.** Pressure levels, ammonia – HCFC 22 comparison.

Parameter	Refrigerant									
	Ammonia					HCFC 22				
Temperature ( $^{\circ}\text{C}$ )	-20	-10	0	10	20	-20	-10	0	10	20
Pressure (bar)	2	3	4.2	6.6	8.4	2.8	3.7	5.1	7	9.3

**Table 5.** Thermal properties, Ammonia – HCFC 22 comparison.

Refrigerant	Specific Heat (kJ/kg K)	Thermal Conductivity ( $\text{W}/\text{m}^2 \text{K}$ )	Viscosity (m Pa·s)
Ammonia	4.57	1.82	0.204
HCFC 22	1.16	0.341	0.248

**Table 6.** The influence of the compression ratio ( $\beta$ ) on the specific refrigerating power ( $q_0$ ).

Parameter	Refrigerant							
	Ammonia				HCFC 22			
$\beta$	4	6	8	10	4	6	8	10
$q_0$ (kJ/kg)	1000	998	987	980	160	158	157	150

**Table 7.** The influence of the compression ratio ( $\beta$ ) on the specific refrigerating power ( $q_0$ ).

Parameter	Refrigerant							
	Ammonia				HCFC 22			
$\beta$	4	6	8	10	4	6	8	10
COP	4.3	2.9	2	1.5	3.4	2.2	1.8	1.4

Ammonia shows a low freezing point, a small vapour volume – leading to small size compressors, similar vapour pressure with HCFC 22 – indicating similar operating conditions (but it requires steel pipes), superior thermal properties than HCFC 22 – meaning better heat transfer in the evaporator and in the condenser, a lower viscosity compared to HCFC 22 – small sized pipes, superior specific refrigerating power compared to HCFC 22 – low mass rates; ammonia is more efficient from the energetic point of view, presenting a superior COP when comparing to HCFC 22.

#### 4. Conclusions

The Holy Quran offers plenty of scientific statements which are in perfect consonance with modern scientific discoveries. The words of Allah Almighty described the ozone layer as a protecting and elevated roof, this layer defending and guarding us from the damages coming from above.

Modern science has demonstrated that the ozone filter efficiently screens out almost all harmful ultraviolet rays of the sun. A HCFC phase out timetable was established through international agreement and national legislations, because of their ozone depletion potential.

In order to meet the HCFC 22 phase out schedule are evaluated alternatives for this refrigerant, currently used in marine refrigeration.

Ammonia does not harm atmospheric ozone, unlike chlorine containing refrigerants, which remain in the atmosphere so long that the ozone layer will not fully repair itself until at least the middle of the 21 century. The fact that the ozone layer is able to cure itself is also stated in the Holy Quran.

The comparison ammonia – HCFC 22 made in the study showed that this natural refrigerant can replace successfully the one which is ozone depleting, due to its excellent thermo-physical properties and very good energetic performance.

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