# LIGHT-TRANSMISSION OF DIRTY GLASS AND CLEANING METHODS

IR. Y. VAN KOOT and T. DIJKHUIZEN*

Experiment Station for Vegetable and Fruit growing under glass,
Naaldwijk, The Netherlands

## Summary

Light-transmission of dirty glass and cleaning methods

The light transmission of ordinary and diffusing glass were compared; thickness, age and colour of the side were taken into account. The origin of dirtyness of the glass has a typical influence on the spectral composition of the transmitted light. In this respect dirtyness caused by air-pollution, iron-deposit from water and the use of shading materials was studied.

As to the cleaning of glass, showering with water, the use of oxalic acid and the use of a fluor containing compound were compared. Automatisation of cleaning is possible in practice by the installation of turning sprayers on the roof of the glasshouses. Some types of sprayers were compared.

## Sommaire

Saleté de verre et nettoyage

La transparence de verre normale et de verre martelé était comparée, tandis que l'épaisseur, l'âge et la couleur de plan d'intersection sont considerées aussi.

La nature de la saleté du verre a un influence caractéristique á la composition de la lumière passante. A ce point de vue sont comparées: saleté à cause d'impurités de l'air, de formation de rouille et de l'usage de matérial d'abri.

Par rapport au nettoyage sont compatés: le lavage au jet d'eau et l'usage d'acide oxalique et d'agents contenant fluor. Nettoyage automatique semble d'être possible en pratique au moyen de l'installation d'arroseurs sur les toits des serres. Quelques types d'arroseurs sont comparés.

## Zusammenfassung

Lichtdurchlassung von schmutzigem Glas und Reinigungsmethoden.

Die Lichtdurchlassung von gewöhnlichem Glas und Gartenklarglas wurden verglichen; Dicke, Altertum und die Farbe des Bruchflaches wurden berücksichtigt. Die Natur der Verschmutzung des Glases hat einen typischen Einflusz auf der Spektralzusammensetzung des durchgelassenes Lichtes. In dieser Hinsicht wurden Verschmutzung durch Luftveruntreinigung, durch Eisenabsetzung aus Wasser, und durch den Gebrauch von Schirmmaterial bestudiert.

Hinsichtlich der Reinigung wurden verglichen Spritzung mit Wasser und Verwendung von Oxalsäure und einem Fluorenthaltenden Mittel. Automatisierung der Reinigung mit Wasser ist in der Praxis möglich mittels Anlage von Schwingregnern auf dem Dach des Gewächshauses. Einige Typen von Regnern wurden verglichen.

The purpose of our work about light-transmission was to determine to which extent the supply with light of the crops grown under glass depends on the type of glass and its condition. Spectro-photometer measurements have been done about the light-transmission at the following series of wave-lengthes: 315 - 160 - 400 - 455 - 510 - 560 - 610 - 655 - 700 - 850 and 1000 mm (angle of incidence 90°).

In the first place we have tried to get an idea about the eventual changes in light-transmission after the glass has been used over a long period. Even after a most effective cleaning of old glass it often looks somewhat less bright than new glass. A correct comparison of new and old glass is not possible because we have no exact information about the original quality of the old glass. One should keep in mind that the differences in light-transmission between glass-samples of different quality (recognisable among others by the colour of the side) are much larger indeed than the effect of ageing (fig. 1, comparing the lightgreen and the bluegreen glass). There is a tendency, that the transmission of the short wave radiation becomes less during the ageing process (fig. 1, comparing new and 40 year old glass, both bluegreen). In this case it is highly probable that the original quality of the old glass was not less than that of the bluegreen new glass, as the long wave radiation is transmitted still better. Nevertheless the transmission of the short wave radiation in undoubtedly less. Perhaps light becomes somewhat more diffused in the old glass. However these results were obtained under conditions of minimal loss of diffused light (fig. 2, position A).

The thickness of the glass has only a very small effect on the light-transmission. In most cases this factor can be neglected.

To determine the light-transmission of diffusing glass, the glass slides were mounted in two different positions (fig. 2), namely as near as possible to the photocell (minimal loss of light by diffusion, position A) and as near as possible to the slit (more loss of light by diffusion, position B). In position A only slight differences in light-transmission were obtained between diffusing and not-diffusing glass of comparable quality (fig. 3). It is obvious that the quality of the glass (recognisable by the colour of the side) has a much larger effect on the light-transmission than the corrugating of the glass.

In position B the differences in light-transmission between ordinary and diffusing glass were somewhat larger. The light-transmission in both positions was compared with lightly corrugated and strongly corrugated glass (table 1). With both types of glass the light-transmission in position B is slightly reduced in comparison to position A, especially with regard to the short wave lengths. These differences were more distinct with the strongly corrugated glass than with the lightly corrugated glass.

The influence of the type of glass on light-transmission is of minor importance in comparison to the influence of the different types of pollution of the glass. Three types of pollution have been studied, namely: shading with chalk, air-pollution (soot and dust) and iron-deposit from water. The use of chalk as a shading material has the advantage, that the transmission of all wave-lengths is reduced to nearly the same degree (fig. 4). Dirty glass from air pollution has quite an other effect. In this case the transmission of the short wave radiation is reduced much more than the transmission of long wave radiation (a serious case of air-pollution is shown in fig. 4). An iron-deposit from water influences the spectral composition of the transmitted light again in an other way. In this case the transmission of short wave radiation is checked almost completely, whereas the transmission of the long wave radiation is reduced only slightly (fig. 4). It may be expected that with this type of pollution the plants will not only suffer by the diminished total amount of light, but also by the unfavourable composition of the spectrum.

As to the cleaning of glass three methods have been compared: showering with water, the use of oxalic acid and the use of a fluor containing compound. In all treatments the glass was first wetted with water or with the cleaning material (in an amount comparable with a precipitation of about 0,15 mm) and later the glass was cleaned by showering with water. The oxalic acid was used in a concentration of 5 kg in 150 l water and was washed off after 2 hours. The fluor containing compound was used in a concentration of 10 kg in 150 l water and was washed off after 5 minutes. In the latter case it is necessary to wash off the material shortly afterwards, because it corrodes the glass. In practice sometimes the double concentration has been used: such a treatment causes a loss in weight of 1% if the glass is exposed to the chemical during 5 minutes.

The results of these treatments with glass, seriously dirtied by air-pollution, are shown in fig. 5. By cleaning the glass, that is wetted before, with a water-shower the loss of light can be reduced with 60-70%. The cleaning with oxalic acid and with the fluor-compound both give 100% result. The effect of the same treatments with glass with heavy iron-deposit are shown in fig. 6. Showering with water is almost uneffective. Again the treatments with oxalic acid and with the fluor compound are both very effective.

If no iron-deposit is present it is quite good possible to clean the glass of the greenhouses by frequently applied water-shower. It is advisable to clean seriously polluted glass first by a treatment with oxalic acid. Afterwards the glass can be kept clean by regular treatments with water early in the morning, when the glass is still wet. The frequency of showering with water depends upon the weather-conditions, but in total 60 - 75 treatments a year will be sufficient.

The only way to realise such a frequent cleaning is to install turning sprayers on the roofs of the glasshouses. We have experience with 2 types of sprayers, a rather small one (diameter nozzle opening 7 mm, water-consumption 3 $m^3$ per hour, range 19 m) and a larger one (diameter nozzle opening 12 mm, water consumption 9 $m^3$ per hour, range 22 m). The range mentioned applies to calm weather; strong winds influence the range unfavourably, another reason for spraying early in the morning. With both sprayers the water pressure at the opening is 2,5 atmosphere (most of our glasshouse-holdings don't have a pump, that can realize a higher pressure). The larger sprayer (fig. 7) gives a much heavier water-jet and consequently a better result. With this type of sprayer it is sufficient to spray during 5 minutes (precipitation 1 mm). For a glasshouse surface of 3000 m2 one needs 4 such sprayers, for 6000 m2 8 and for 12000 m2 15 sprayers (fig. 8).

If the glasshouse has a programmation-apparatus for automatic watering in the greenhouse, most times there is a sufficient number of connections left to control automatically the turning sprayers on the roof. In this case automation of the cleaning is possible without extra costs. Somewhat more money has to be invested (0,35 - 0,40 Dfl per m2 as against 0,20 - 0,25 Dfl with automation), but the yearly costs are less (0,06 - 0,07 Dfl per m2 as against 0,07 - 0,08 Dfl without automation).

This way of cleaning is only possible, if one has available water with a low iron content. For the use inside the greenhouse a limit of 4 mg iron per 1 is sometimes mentioned, for the cleaning of glass it is safer to keep to a limit of 2 mg per 1. If the water contains too much iron it is possible to avoid precipitation by adding polyphosfates. When the iron-content of the water is also too high for use inside the greenhouse, it is preferable to buy an installation to get rid of the iron in the water. More money has to be invested, but the yearly costs, as far as they have to be put on account of the cleaning, will not be more than 0,01 Dfl per m2 extra.

Discussion:

K.C. Cokeley: (U.K.).

I) Is it necessary to wash with clean water after using exalic acid for removing pollution?

II) Has oxalic acid cleaning had any effect on the glasshouse structure - wood, metal etc. ?

Van Koot:

I) Two hours after the glass has been wetted with 3% oxalic acid, this material is washed off by means of a water shower.

II) Harmful effects as is the case with the fluor compound have not yet been noticed. However it needs time to get the fluor compound replaced by oxalic acid in practice. Therefore it is not at this moment possible to say definitely that oxalic acid is harmless under all conditions.

G.F. Sheard (U.K.):

Could Dr. Van Koot indicate

(a) whether his work included deposits from boiler flues particularly in oil-burning installations.

(b) whether the fluor compound was solid or liquid, and what was its composition.

Van Koot:

(a) Things are indeed somewhat more complicated than is shown in the figures presented. This is especially so when, for shading purposes, a calcium compound which sticks to the glass is used and this becomes mixed with deposits from oil-burning installations and has dried upon the glass. Then it is quite impossible to clean the glass with a water shower and treatment with oxalic acid is necessary.

(b) The fluor compound was solid, its composition unknown.

R. Gardner (U.K.):

Have any experiments been conducted in Holland to ascertain the extent to which crop yields are reduced by a) dirty glass compared with glass which has been cleaned and b) glasshouses which have been shaded with lime (calcium carbonate)compared with no shade used?

Van Koot:

No special experiments have been carried out in Holland to compare the yield in glasshouses with dirty glass and with cleaned glass, or to compare the yield in shaded and non-shaded glasshouses. However we have a lot of experiences (proved by light measurements) that indicate that more light gives an earlier and higher yield.

E.S. Trickett (Australia)

Can Dr.van Koot give any figures for the weight per unit area of the contamination on the samples of glass for which he showed transmission figures?

Van Koot:

These figures are not available.

* The research was mainly carried out by T. Dijkhuizen
Further data were provided by D. de Bakker, W. den Boer, J. van der Does and J.P.N.L. Roorda van Eysinga.

Table 1. Lighttransmission of diffusing glass.

| Wavelength nm | Light-corrugated | | Strong-corrugated | |
|---|---|---|---|---|
| | Position A | Position B | Position A | Position B |
| 400 | 88 | 86 | 88 | 86 |
| 455 | 88 | 87 | 88 | 85 |
| 510 | 90 | 87 | 89 | 85 |
| 560 | 90 | 88 | 90 | 87 |
| 610 | 90 | 88 | 89 | 88 |
| 655 | 89 | 89 | 86 | 85 |
| 700 | 89 | 88 | 85 | 83 |

Fig. 1

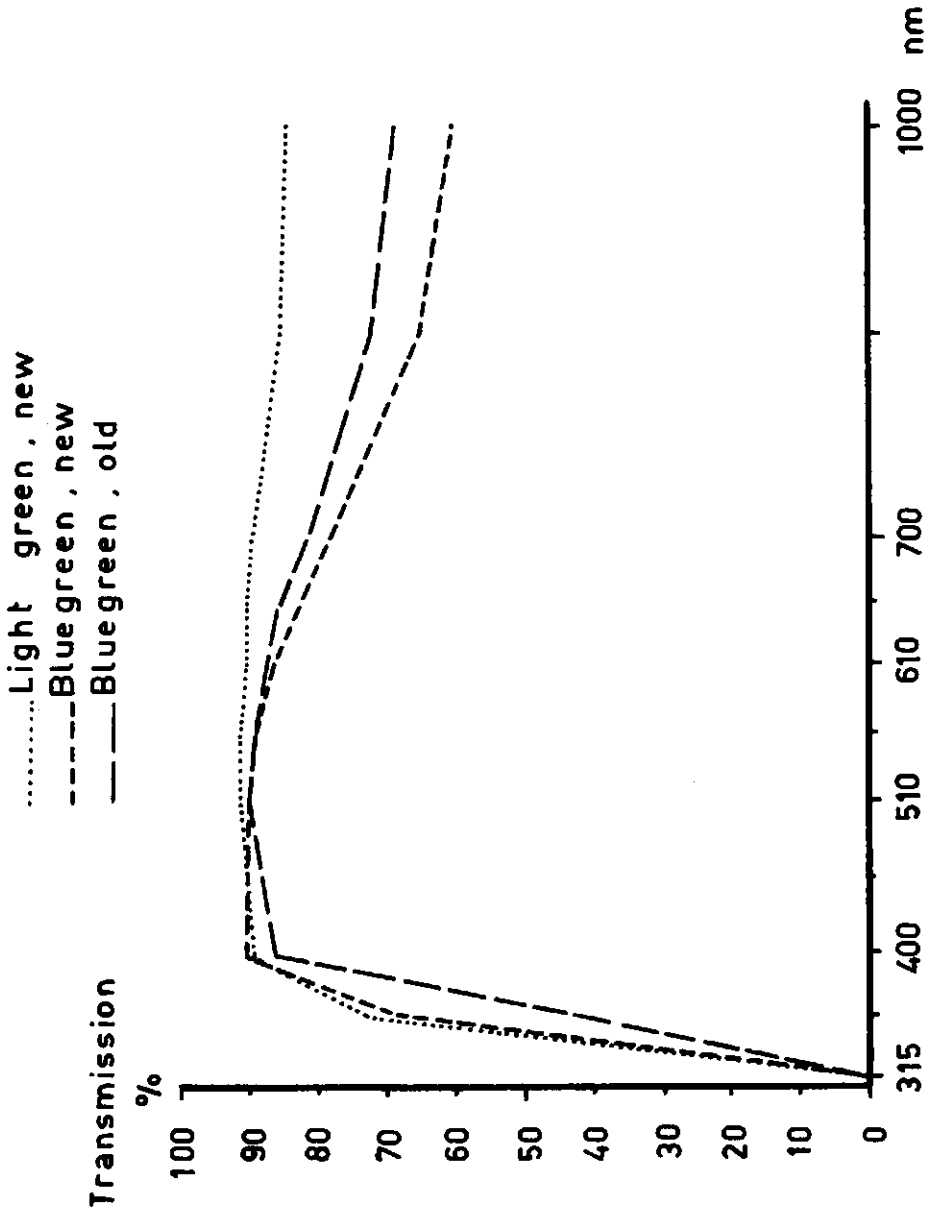

Light green, new
Blue green, new
Blue green, old
Transmission %
100
90
80
70
60
50
40
30
20
10
0
315
400
510
610
700
1000
nm

Fig. 2

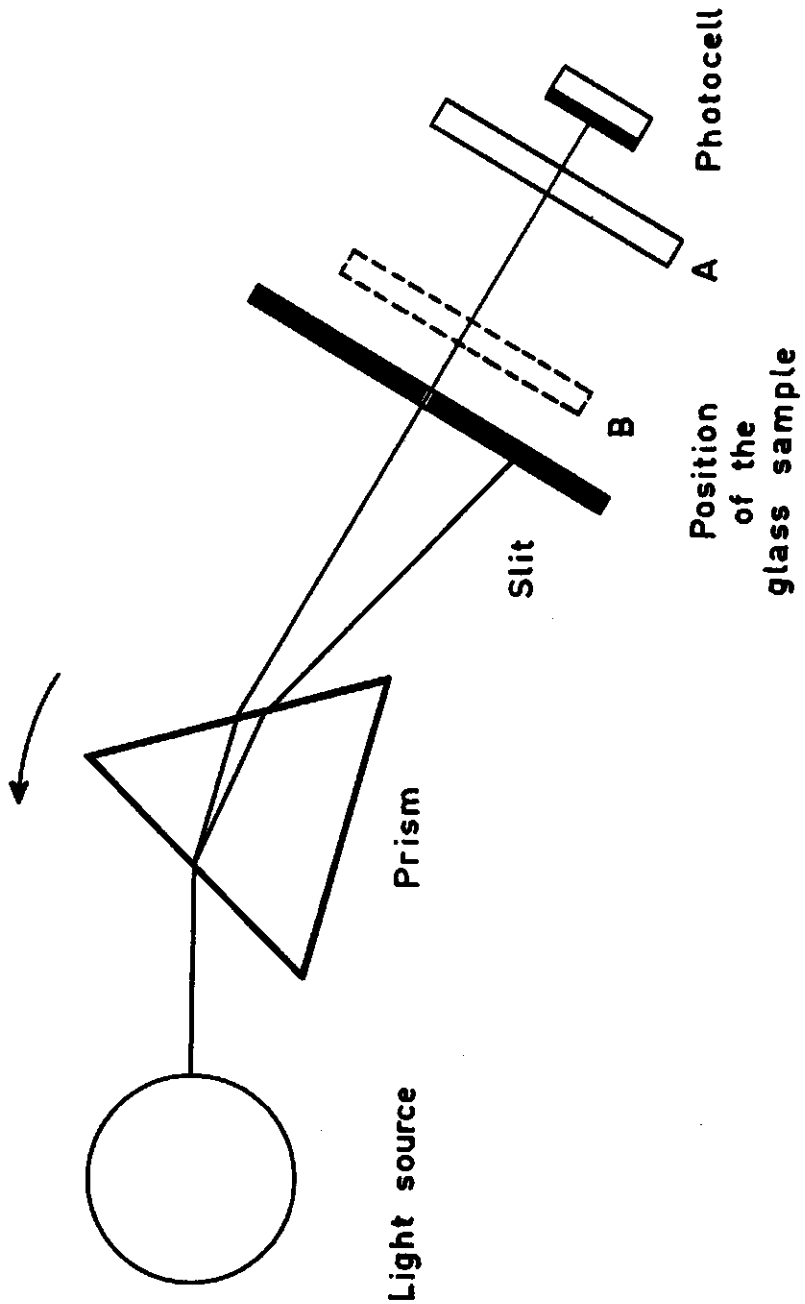

Light source
Prism
Slit
Position of the glass sample
B
A
Photocell

Fig. 3

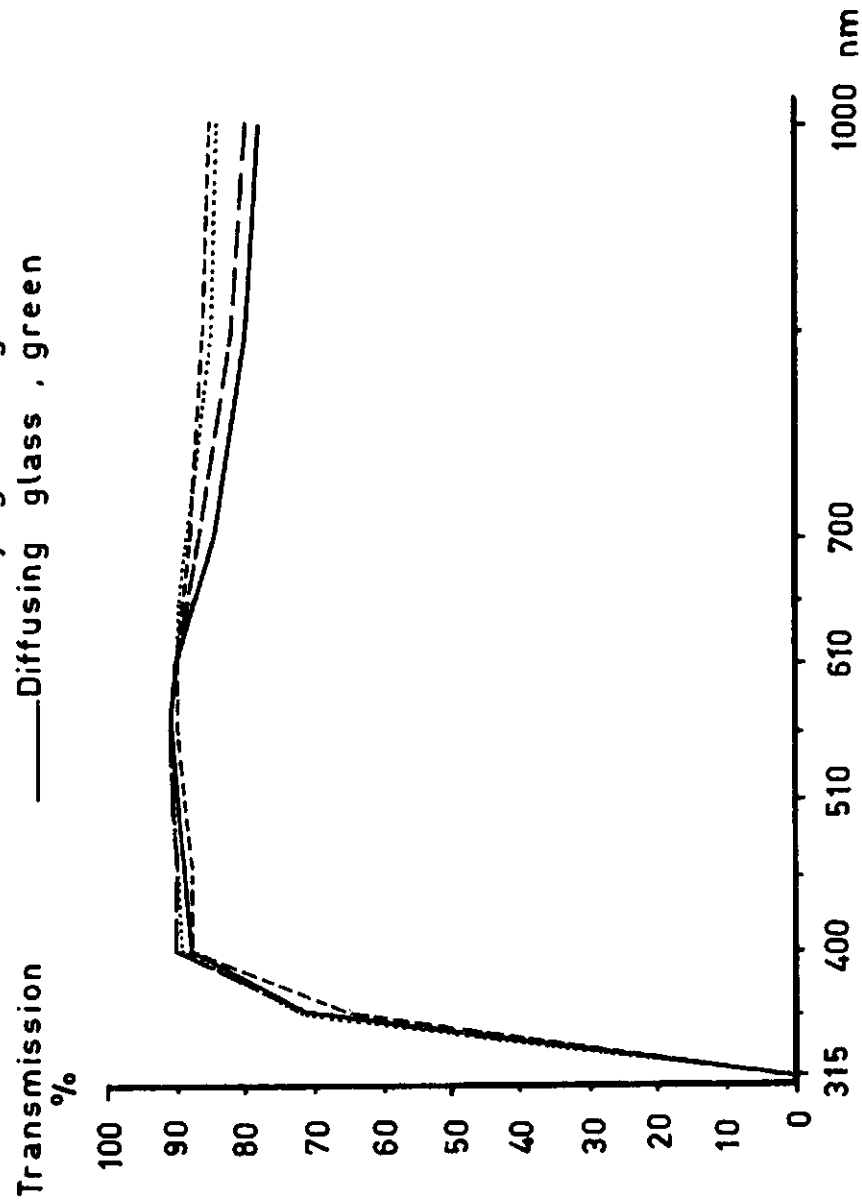

.....Ordinary glass , light green
-----Diffusing glass , light green
——Ordinary glass , green
——Diffusing glass , green
Transmission %
100
90
80
70
60
50
40
30
20
10
0
315
400
510
610
700
1000 nm

Fig. 4

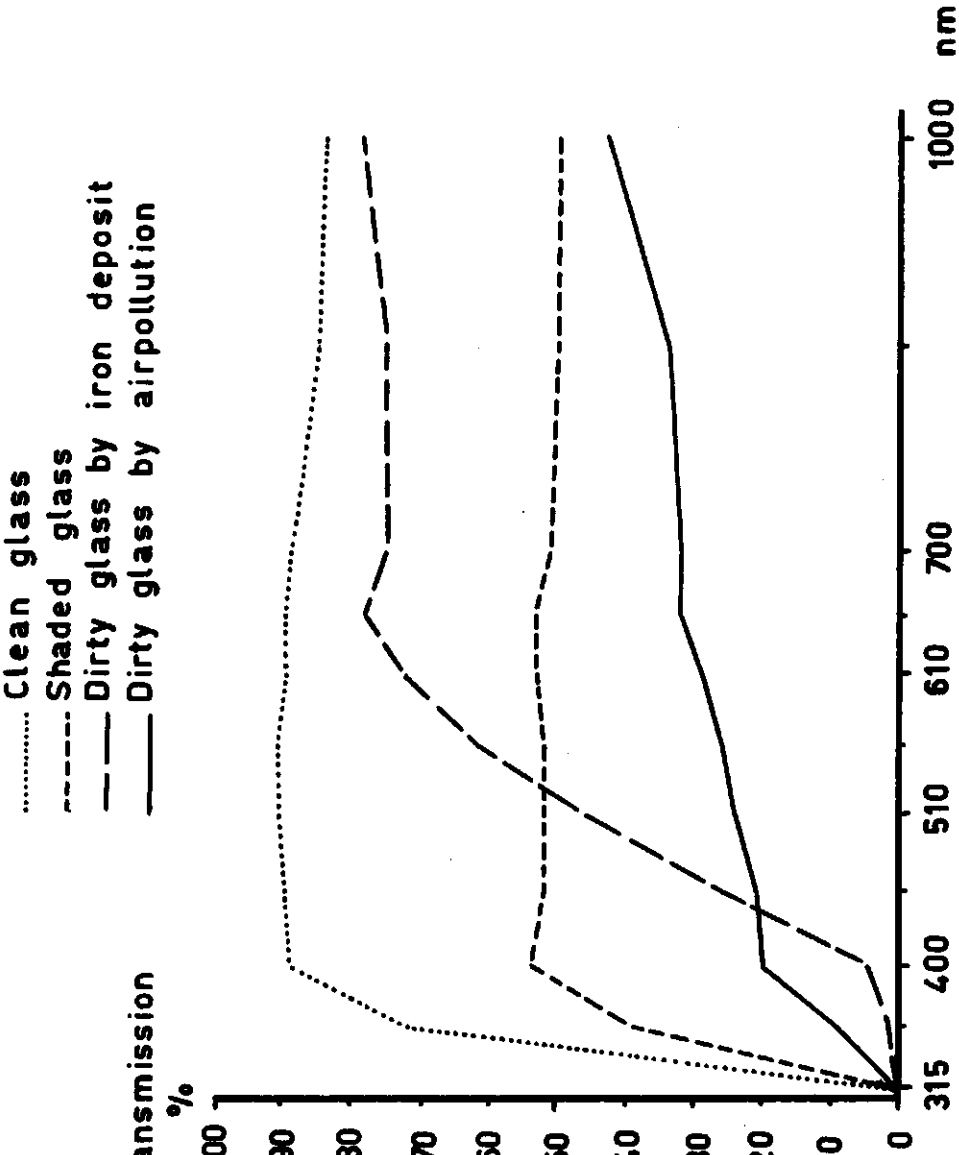

Clean glass
Shaded glass
Dirty glass by iron deposit
Dirty glass by airpollution
Transmission %
100
90
80
70
60
50
40
30
20
10
0
315
400
510
610
700
1000
nm

Fig. 5

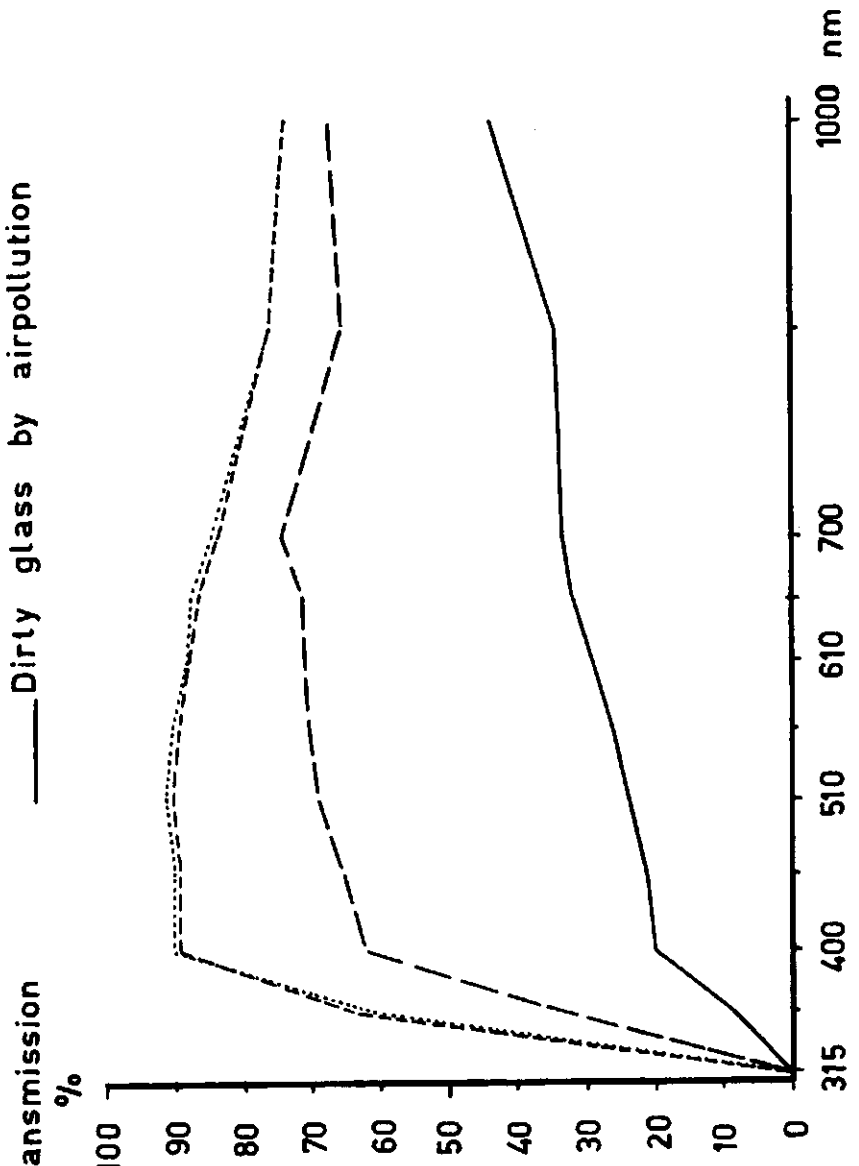

.....Cleaned with oxalic acid
-----Cleaned with fluor compound
— — Cleaned with Water
——Dirty glass by airpollution
Transmission %
100
90
80
70
60
50
40
30
20
10
0
315
400
510
610
700
1000 nm

Fig. 6

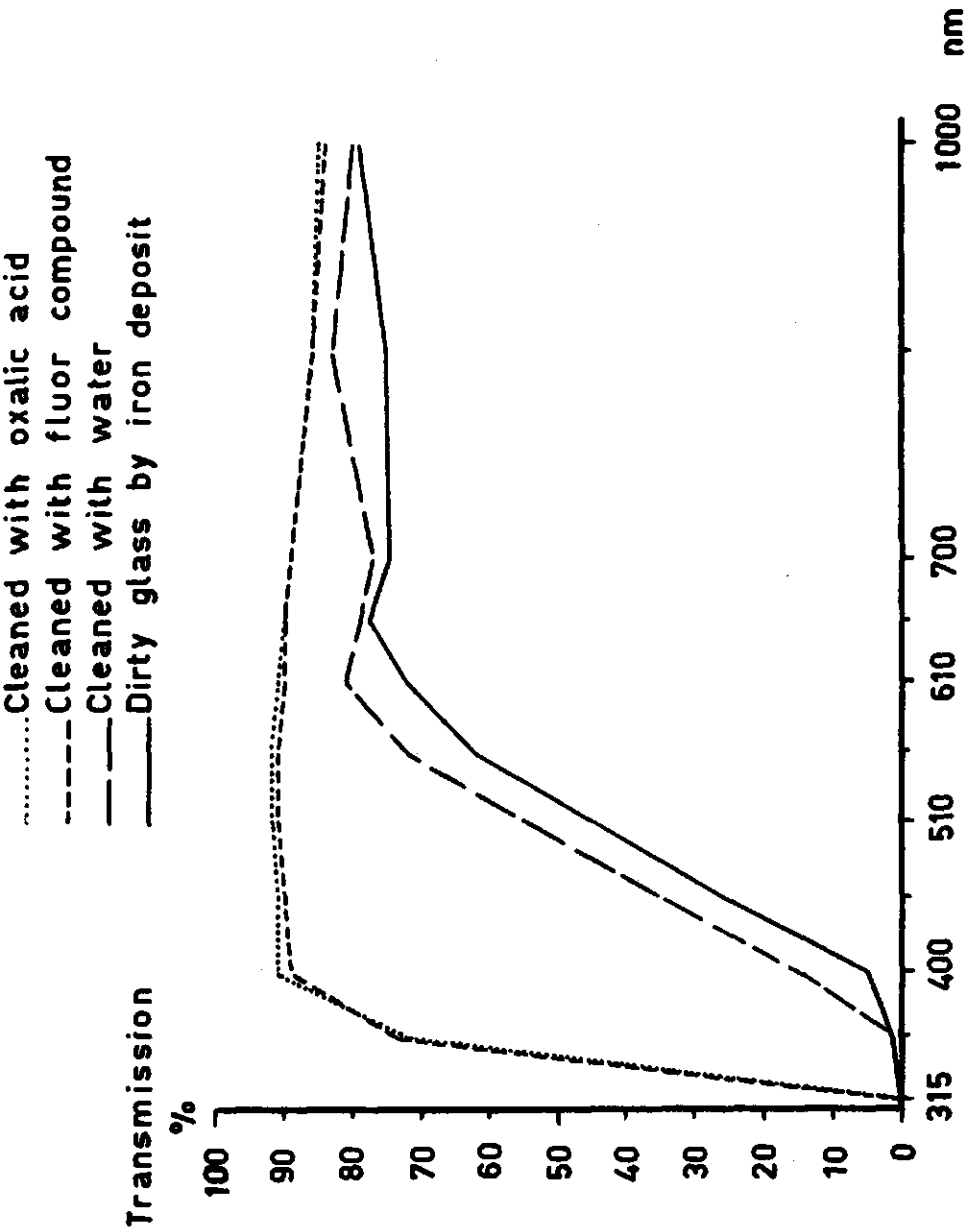
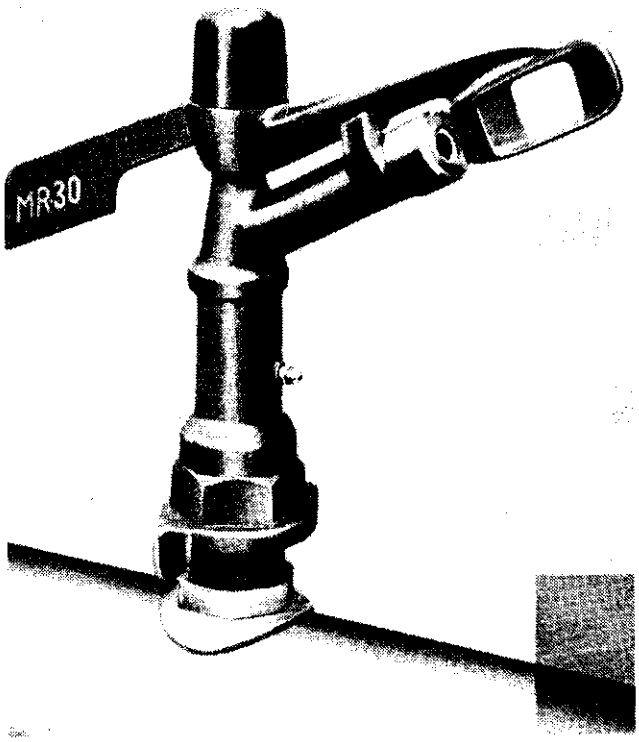

.....Cleaned with oxalic acid
- - - -Cleaned with fluor compound
— —Cleaned with water
——Dirty glass by iron deposit
Transmission %
100
90
80
70
60
50
40
30
20
10
0
315
400
510
610
700
1000
nm

Fig. 7



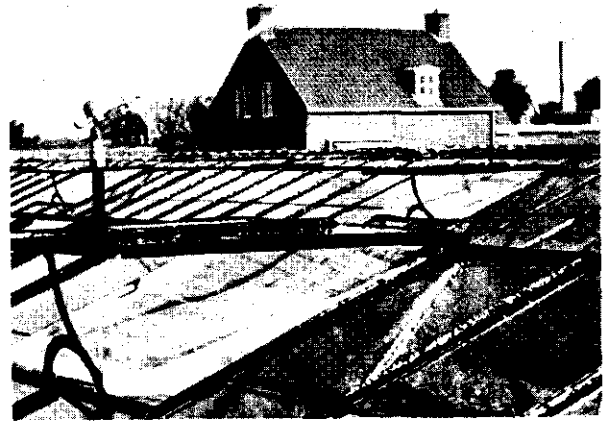



Fig. 8