A ENERGY SAVING HID LUMINAIRE WITH SPECIAL REFLECTOR FOR LOW BAY USE

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ABSTRACT

This report describes a special reflector producing a controllable direction spread light beam which replaces the original reflector-diffuse reflector or aluminium reflector with wave shape surface. The light output of this reflector is higher. It could be installed with a prism bowl reducing the luminances at high angles. Therefore, the new type of luminaire limits the discomfort glare down to a low level and could be used for low bay industry shoplighting.

INTRODUCTION

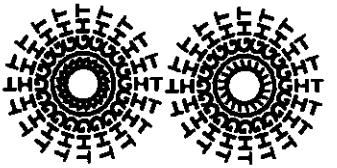
More than ten years ago, a luminaire composed with 250 - 400 W HID (Metal halide lamp & HPS lamp) lamp and diffuse reflecting surface reflector installed a prism bowl on "exit" face had come out of surmounted obstacles of high luminance on its "exit" face. The basic way is to make the opalescent coating (power coat enamel) on the smooth surface of reflector to replace the polishing anodizing of aluminium reflector. The internal non-directive reflection of the reflector makes a much larger flash area on high angles (~60°), it is uniformly over these observation angles and shown by fig. 1.

partly flash area at a polished surface

all the brilliant exit face by opal-escent coating

Figure 1 The flash area compared for two kinds of reflector surface

Lightbeams reflect to prism bowl and are further spread to show a larger and uniform flash area. It diminishes the high angle glare, the average luminance value of it could be reduced within the limit of interior lighting standard.



In general say, less than 40 000 cd/m^2 is satisfied to industry lighting for low bay use. The light output ratio of the luminaire is about 60%.
After this, another luminaire using a polished aluminium reflector having wave shape reflecting surface was taken. Fig. 2 is the sketch diagram.

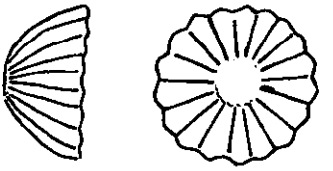


Figure 2 Sketch of wave shape reflector

The curve of the reflector is calculated by following rule:
The demand lights of one reflecting direction are provided by one segment of reflection only, it shows at fig. 3.

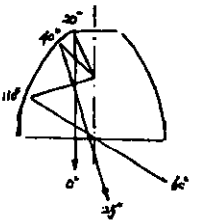


Figure 3 The different segments of reflector reflect the beams into different direction

Beams are reflected by wave shape to their positions of reflector. It means that a small length of one wave shape could reflect light into a wide angle with different angle, fig. 4.

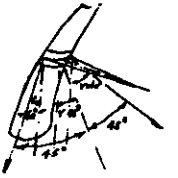
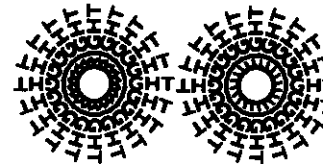


Figure 4 One section on the wave shape surface to reflect beams into wider angles.



Then falling down to the prism bowl, fig. 5 shows the flash area of viewing angle at 60° on bowl. it shows us that the flash area is partly of prism bowl, and cannot cover all the "exit" face. For this reason, the glare on high angles could be increased, but the light output ratio is higher than the former by means of the polishing aluminium reflecting surface. The light output ratio of luminaire is about 65%.

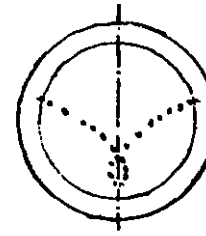
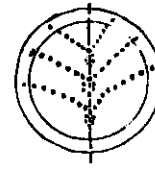


Figure 5 The flash area of viewing angle at 60° on bowl

AN IMPROVED METHOD FOR WAVE SHAPE REFLECTOR

In order to enhance the uniformity of luminance of prism bowl at 60° observation angle, the curve of reflector must be improved to make it with following speciality.
While keeping up the light output ratio of the reflector the same as that of the wave shape reflector, the reflecting light distribution form the reflector must be controlled to be similar in appearance of diffuse coating reflector. To this purpose, fig. 6 shows the new idea of the improved wave shape curve.

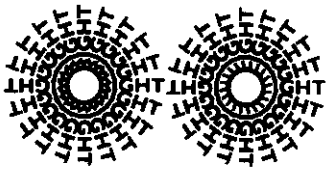
a) Two of the new ideas of reflector curve



b) Reflecting beams onto three segments of curve

c) The neighbouring segments are moved over a phase angle

Figure 6 The improved method of the new reflector



1 Some segments on reflector provide the direction of reflected light to a larger range of angles. Beams reflected by AB and BC on fig. 6a can be redistributed to cover an identical range 45° - 60°. It means that reflected beams fall on the prism bowl in a much more spread area producing a more uniform luminous area at observation angle than with the wave shape curve. Fig. 6b is the intersection of reflecting lights from reflector onto prism bowl.

2 In addition to retain the cross section curve is like in the former case - wave shape, the section curve of neighbouring segments are rotated by a phase angle of 90° about their optical axis. Fig. 6c is the principle diagram. The change of the up and down segments interlacing each other makes a much more uniform light distribution on the prism bowl.

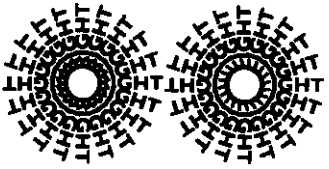
AN ECONOMIC ANALYSIS OF SAVING ENERGY FOR NEW HID LUMINAIRE

Using HID luminaires with improved reflector at low bay places shows a marked increase (about 9%) of light output ratio over the original type - diffuse coating reflector and clearly creates a much more uniform luminous area to the observer at high viewing angles as compared with luminaires with fluorescent lamps. Fig. 7 gives the comparing data for both luminaire types.

included lamp type and number	luminous flux (lm)	light output ratio of luminaire (%)	lamp and ballast power (W)	lamp life (h)	cost of luminaire (yuan)	cost of lamp (yuan)
HID luminaire with 250 W halide lamp	20500	62	250+40	10000	1000	
2x 40 W fluorescent luminaire	2x 2000 = 4000	65	2x(40+9)	4000	240	

Figure 7 The data for 250 HID luminaire and 2x 40 W fluorescent luminaire

It tells us, one HID luminaire with a 250 W metal halide lamp could be used instead of five fluorescent lamp luminaires with 2 fluorescent lamps of 40 W. For engineering practice, a compressor assembly shop originally had 1000 fluorescent lamp luminaires (2x 40 W), which have now been replaced by



200 HID luminaires with a 250 W metal halide lamp.
As the data of fig. 8 shows, the shop will save energy 8000 kWh (10 years) and money 846400 yuan (10 years).

	First investment luminaire cost (yuan)	Electrical fee (yuan)	lamp fee (yuan)	maintenance fee (yuan)	sum (yuan)
5 sets of 2x 40 W flu. lamp luminaires	5x 240 = 12000	8820	one per year 10x10x6.5 = 650	250	10920
1 set of 250 W HID luminaire	1x 1000 = 1000	5520	4 times per 10 years 4x107 = 428	10	6658

Figure 8 Economic analysis for HID luminaire and fluorescent luminaire during 10 years

* It just includes the cost of luminaire, excludes the saving of electrical materials.
* The electrical fee is 0.45 yuan per kWh.
* The working time for luminaire is 4000 h per year.
* Labour cost is 10 yuan per hour, changing a new lamp in about 1/4 hour.

CONCLUSION

The HID luminaire for low bay use is a saving energy product. Considerable energy and money could be saved while applying it in new engineering practice or at the reconstruction of an existing lighting installation. One HID luminaire with 250 W metal halide lamp may be used instead of 5 fluorescent lamp luminaires (2x 40 W).
It is very popular to use recessed fluorescent luminaires (2x 40 W) e.g. in the food, textile, medicinal and paper industry. Now we can confirm that the new HID luminaire will become popular and will have a very bright application future.