
# Analyzing Enerconcept's Glazed Transpired Solar Collector Design

## Transpired Collector Design

The Lubi™ collector is a transpired glazed collector with multiple perforations and a fixed porosity (open area) of 1.2% across the polycarbonate surface.

Its basic operating principle taken from the Lubi Technical Manual (with schematic) is stated as: *"All glazed solar thermal collectors, whether it is for air or water heating, lose most of their heat through the front glazed surface. This can be felt when the glazing gets warm: in this case, the collector is losing heat to the environment. The basic principle of the Lubi system consists in reducing these heat losses to the environment to a minimum.*

*The Lubi system reduces heat loss by means of multiple perforations spread across the entire glazing surface through which incoming outside air is admitted.* ***When the system is designed properly, the entire Lubi glazing surface remains at ambient temperature, thereby, eliminating heat losses on the collector's surface.****"*

How does one determine whether uniform air flow is occurring across an entire wall with thousands of perforations and what happens when uniform air flow is not achieved?

Infrared (IR) images are commonly used to check surface temperatures and can be used on solar collectors to locate hot or cold spots which would indicate uneven air flow. IR images were taken on a number of Lubi Collectors to determine whether air flow is uniform across the entire Lubi collector as per the Lubi Technical Manual.

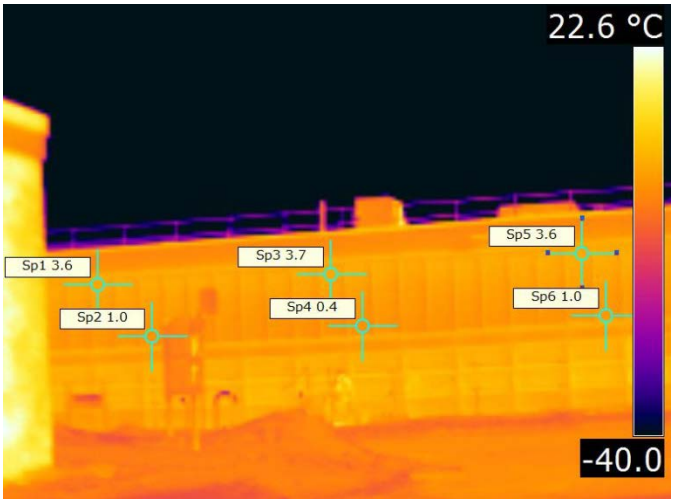
Dr. Andy Walker, an expert on transpired collectors at the National Renewable Energy Laboratory in Colorado, states in his book, Solar Energy, Solar Ventilation Air Preheating chapter, (Wiley 2013): *"Pressure drop across the absorber has important implications for design recommendations. Experts previously recommended a face velocity of 4 cfm/ft$^2$ as sufficient to maintain the recommended 25 Pa pressure drop across the collector….A pressure drop less than 25 Pa across the absorber may be overcome by wind and buoyancy effects, such that air comes out the holes rather than in, and reduces the efficiency of the heat collection."*

The book also states: *"As the flow rate is decreased, the pressure drop decreases, and the flow becomes less uniform. In the mildest case, there will be hot spots farthest from the points at which the air is drawn into the building….In extreme cases, if the pressure drop is extremely low, air can blow out of the collector near the top due to stack effects even if the wind is not blowing."*

**Let's examine a few Lubi Collector installations**.

**Project #1:** The 860 ft$^2$ Lubi system pictured below is on a cosmetics plant in Montreal. The next image is of the identical wall taken with an infrared camera and it shows relatively uniform temperatures across the surface

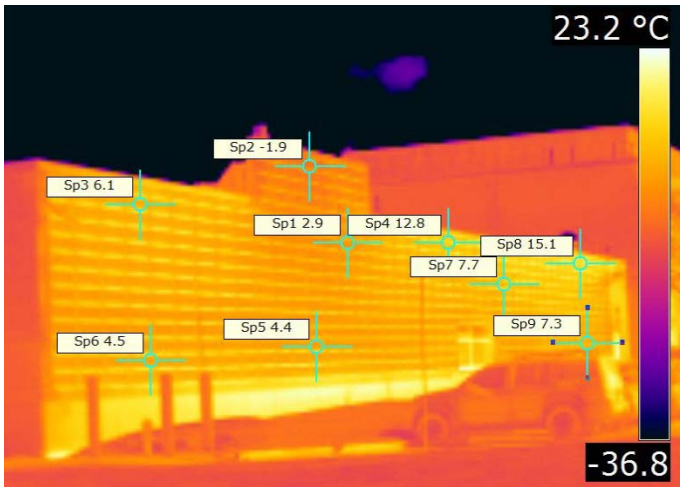
of the Lubi wall collector.




With over 5000 cfm of incoming air and a centrally located wall intake, the flow rate is over 6 cfm/ft$^2$. The uniform temperatures and no hot spots (a variance of 2 to 4 C° from bottom to top is normal) indicate that air is entering through each perforation to cool the entire surface and that the 25 Pa pressure drop is likely being maintained across the collector.

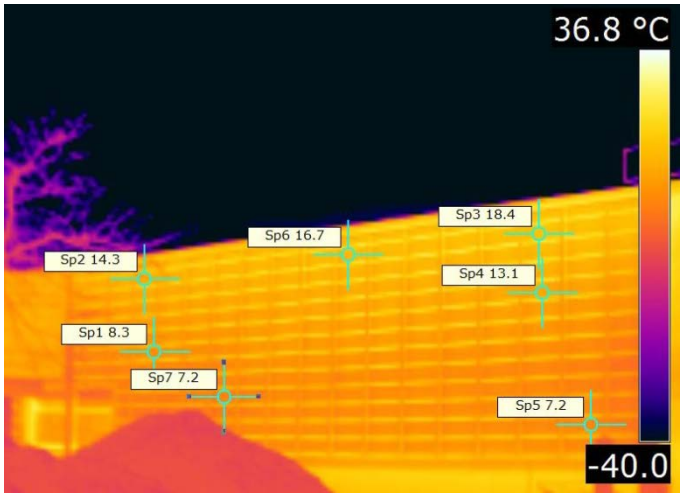
**Project #2:** The next series of photos show a 1905 ft$^2$ (177 m$^2$) Lubi system on a distribution center with the air intake at approximately ¼ of the wall length from the left side. The air intake is roof mounted and located behind the raised wall section.

The fan draws 11,500 cfm which should be 6 cfm/ ft$^2$ over the entire surface.




The above IR image of the entire Lubi Collector shows uniform air flow under and to the left of the fan but shows a hot section along the top right side. The next IR image depicts the right half of the Lubi collector and clearly shows the top portion to be 10 to 16 C° warmer than the Lubi collector near the fan.

These IR images, taken on a day when ambient was -12 C°, show collector surface temperatures as high as +18.4 C° which indicate heat outflow.




A well designed wall at 6 cfm/ ft$^2$ should not have hot spots, so what may be causing this problem? Note that the fan is not centered on this wall; instead it divides the wall into ¼ and ¾ sections. The IR images show the fan is drawing up to half of the air from the left shorter side and remaining air from the right longer side. A rough calculation indicates that the left half may be drawing air at 10 to 12 cfm/ ft$^2$ while the longer right side is only drawing at 4 cfm/ ft$^2$.

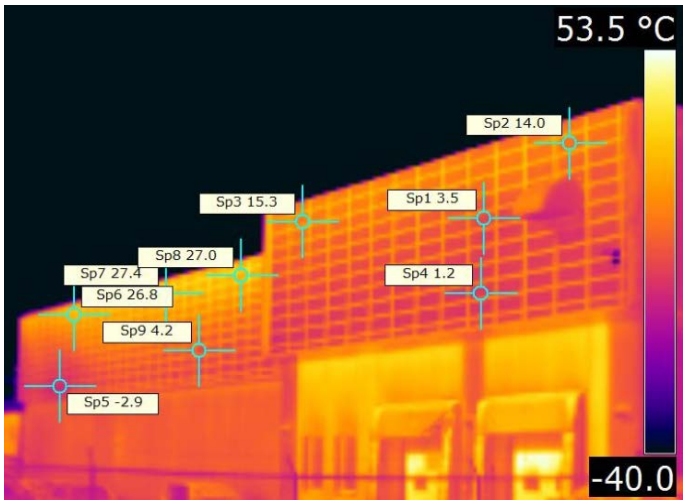
According to Dr. Walker, heat outflow will occur when the pressure drop across the transpired collector is insufficient to counter the buoyancy effects and heat escapes from the holes instead of fresh air entering the holes. In this case, the air intake is too far from the right side of the collector to create sufficient suction to pull air into those perforations, the result being outflow and lost solar heat.

**Project #3:** The next series of photos are of a 4520 $ft^2$ (420 $m^2$) Lubi Collector on multiple elevations of a factory building which is depicted in the Lubi brochure.

The above photo shows the left half of Lubi Collector array and lower photo shows the right half of the array.

The air intake in lower photo for the right wall section can be seen beside the wall hood. Looking at the IR image, a second air intake appears to be at the far left where the IR image reads -2.9 C°. The image also shows significant temperature variation from a low of -2.9 C° by the fan to a high of 27.4 C° along the top.

The 30.3 C° difference indicates that uniform air flow is not occurring on these Lubi collectors resulting in significant heat out-flow along the entire top of the walls and at some mid points. Air is being drawn through




perforations in the Lubi collector near the fans but not through perforations some distance from the fans. These results are consistent with a pressure drop below 25 Pa and a Lubi system operating below the tested and rated flow rate of 4 cfm/$ft^2$.

## Lubi™ Collector Tested Flow Rates

The Lubi SRCC Certificate indicates that the Lubi collector has only been tested at 4, 7 & 10 cfm/$ft^2$ but the Lubi Technical Manual presents data for a fourth flow, that is 2 cfm/$ft^2$ which appears to be unsubstantiated.

| Air Flow Rate |
|---|
| 1.2 scmm/$m^2$ (4 scfm/$ft^2$) |
| 2.1 scmm/$m^2$ (7 scfm/$ft^2$) |
| 3.1 scmm/$m^2$ (10 scfm/$ft^2$) |

The SRCC Certificate lists the maximum temperature rise for the Lubi Collector as 22.5 C° occurring at 4 cfm/$ft^2$ and also states: *Performance is unreliable if the collector is used at a pressure drop of less than 25 Pa because wind influences the performance unpredictably.*

Since the Lubi Collector SRCC Certificate does not include flows below 4 cfm/$ft^2$, then performance below this operating condition has not been certified and the temperature curve for 2 cfm/$ft^2$ shown in the Manual cannot be verified. The IR images would indicate that the Lubi Collector is not designed to operate below 4 cfm/$ft^2$ which is consistent with Dr. Walker's findings.

## Conclusions

According to the SRCC Certification, Lubi™ Collectors have only been tested at 4, 7 & 10 cfm/ft$^2$ and not at 2 cfm/ft$^2$

Dr. Walker presents the main design criteria for ensuring uniform air flow and that is to maintain a pressure drop of 25 Pa across the entire surface of a transpired collector.

Lubi's Technical Manual states *"When the system is designed properly, the entire Lubi glazing surface remains at ambient temperature, thereby, eliminating heat losses on the collector's surface."* Clearly, two of the three installations inspected for this report failed to eliminate heat losses from the entire collector surface.

Lubi Collectors have a fixed porosity of 1.2%, designed for the higher air flows certified by SRCC but this porosity is not suitable for low flows.

One of the installations visited has major heat losses which renders much of that Lubi Collector as unable to collect solar heat energy.

No evidence was found to show that Lubi Collectors can maintain a 25 Pa pressure drop below 4 cfm/ft$^2$; in fact, the IR images and SRCC Certificate indicate that Lubi Collectors are not designed to operate below 4 cfm/ft$^2$.