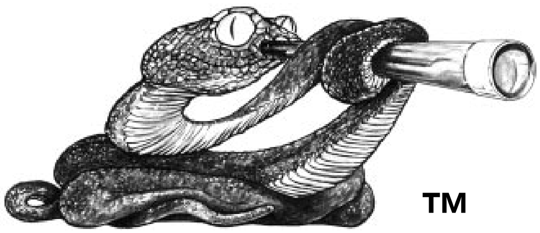
D-Series Handheld IR Scanners



Microscanner

D-Series

The Only *Certified Accurate* Surface Temperature Instrument in the World

D501 and D501-RS

A MUST FOR
ISO 9001
ISO 9002
ISO 9003
TRACEABILITY
PROGRAMS

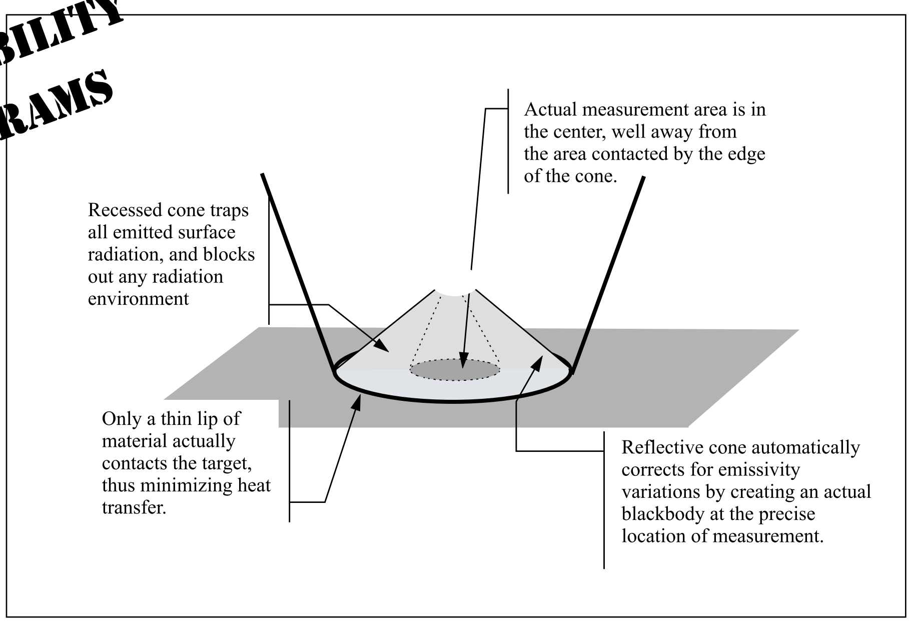


Figure 1. Unique Automatic Emissivity Compensation System (AECS) produces accurate temperatures everywhere the infrared probe is placed, by creating its own blackbody.

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The D-Series is an entirely different type of instrument than conventional temperature measuring devices. Designed specifically for the highest possible accuracy, it is the only infrared instrument which can be certified as to NIST-tracable accuracy on real surfaces of unknown emissivity, while completely free of contact errors and heat sinking errors of contact devices.

	Common Surface Temperature Measurement Errors	Microscanner D-Series IR Thermometers	Conventional IR "Point and Shoot" guns and probes, including laser aimed units	Conventional contact probes, thermocouples, RTDs, thermistors
1	Pre-set Emissivity errors?	no	yes	no
2	Emissivity shift errors?	no	yes	no
3	User adjustment errors?	no	yes	no
4	Background reflection errors?	no	yes	no
5	Contact errors?	no	no	yes
6	Friction heating errors?	no	no	yes
7	Heat sinking errors?	no	no	yes
8	Time based errors?	no	no	yes

1. Emissivity errors

The true emissivity of a surface is known only approximately. Conventional IR devices without Exergen's Automatic Emissivity Compensation System can only display an approximate temperature over their entire temperature range.

The "accuracy" specifications given by most manufacturers are only for a "black body" calibration and do not hold outside laboratory conditions. Black body calibrations do not include emissivity shifts, ambient change effects on the target, and other phenomena that introduce significant errors.

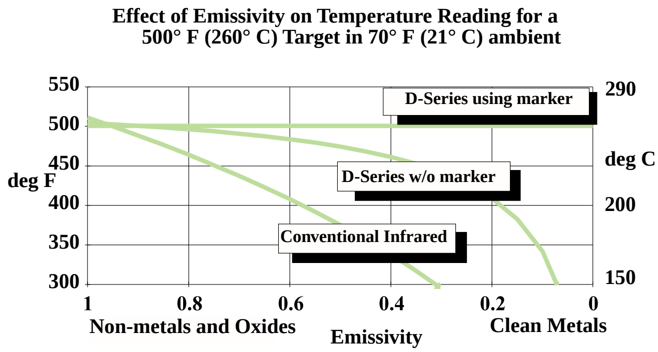
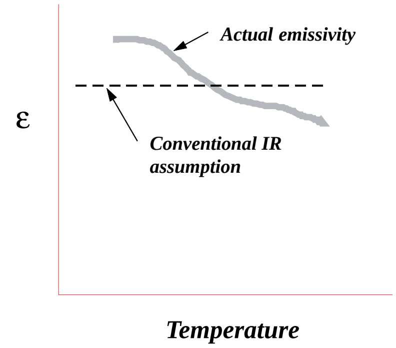


Figure 2. D-Series is accurate over a wide emissivity range, sufficient to include all non-metals. If a marker (or any other non-metal coating) is used, the D-series is accurate on clean metals as well. Conventional IR devices have considerable inaccuracy.

2. Emissivity shift errors

Even if an IR "gun" is set to the correct emissivity to read a surface accurately at a particular temperature, it does not mean that the IR "gun" will read the same target correctly at other temperatures. Emissivity of virtually all surfaces changes with temperature. A common assumption for conventional IR thermometry is that emissivity is constant with changes in target surface temperature. Real materials do not have this characteristic.



3. User adjustment errors

A setting of emissivity = 0.9 on an IR "gun" from one manufacturer will not necessarily match that of another IR "gun" from another manufacturer. There are no standards set in the industry on the precise measurement and meaning of "emissivity".

Also, Quality Assurance programs should not rely upon any instrument that allows users to alter the instrument settings and to let it display whatever the user wishes.

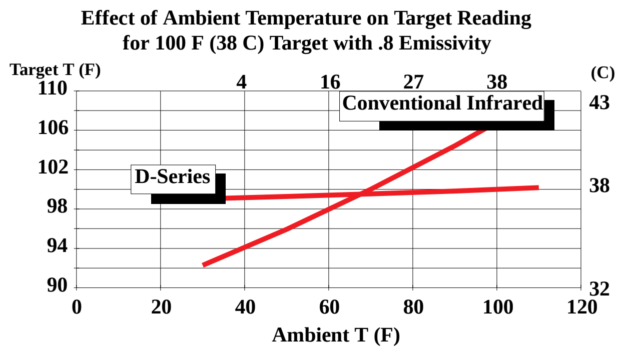


Figure 3. D-Series remains accurate even if the ambient temperature varies, while conventional IR devices have considerable inaccuracies.

4. Background reflection errors

Even if emissivity is constant (see #2), there are still errors induced by changing ambient temperatures. For example, with emissivity = 0.9, ambient reflections account for 10% of the signal that the IR "gun" will see. If ambient changes, the IR "gun" will display a different target temperature, <u>even if the target remains at the same temperature.</u>

5. Contact errors

Thermocouples, RTDs, thermistors and other contact devices <u>only measure their own temperature</u>. They do not measure surface temperature. Published "Accuracy" specifications are for the probes only, not the surfaces they must measure. Users must guarantee that the probes are brought to the same temperature as the surface. Can you guarantee that your probes are brought to the same temperature as the targets to be measured?

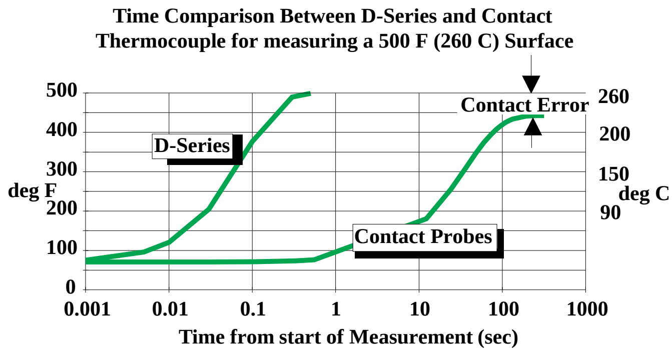


Figure 4. D-Series measures surface temperature in a fraction of a second, while contact probes (thermocouples, RTD's, thermistors, etc.) require many minutes to acheive equilibrium. Contact probes always have a residual error due to imperfect heat transfer from the surface to probe.

6. Friction heating errors

For moving surfaces, a contact probe is prone to frictional heating. The size of the error is dependent on the roughness of the surface, the speed, the coating on the probe, and so on. It is impossible to control all the variables.

7. Heat sinking errors

For most non-metals, heat sinking errors can be quite large. The heat transfer rate of the metal leads required on "contact probes" conducts heat faster than the target material can replace, resulting in unknown and fairly large errors. In general, the less dense the target material, the larger the heat sinking error with a contact probe.

8. Time based errors

Contact temperature probes are slow. The temperature of a target can change more quickly than most probes, resulting in errors in real time measurement.

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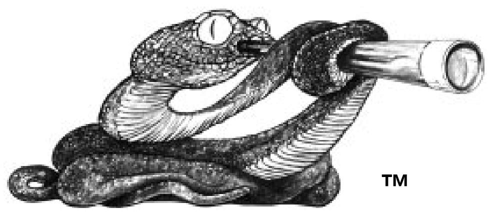


Infrared Psychrometry

with the

Microscanner D-Series:

Measure

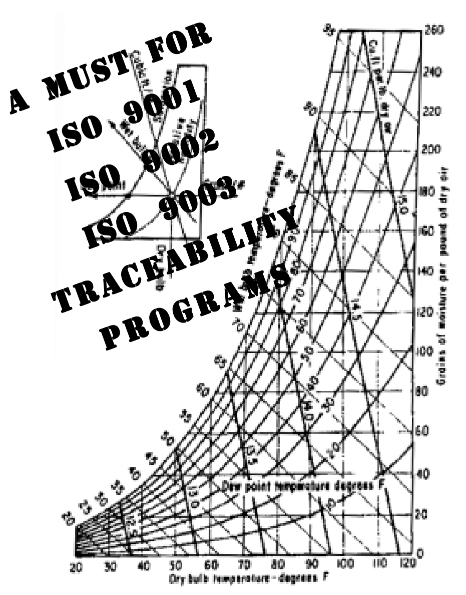
Relative Humidity

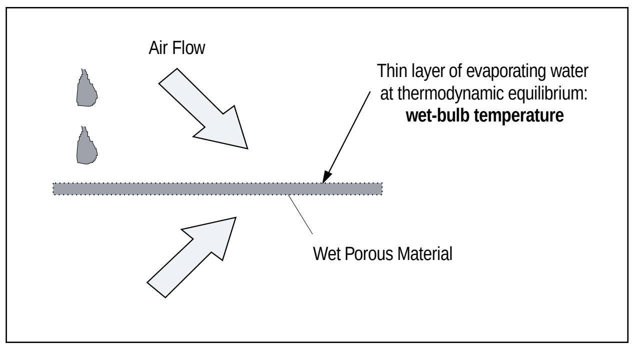
to

Certified Accuracy ±0.5% RH

Psychrometrics, the science of measurement and control of moisture in air, is based entirely on thermodynamics of air and water: the properties and *temperature*. Relative humidity (RH) is one of the common parameters used to describe the psychrometric state of air in an environment, in an oven, or any area where moisture content can influence product quality or personnel comfort.

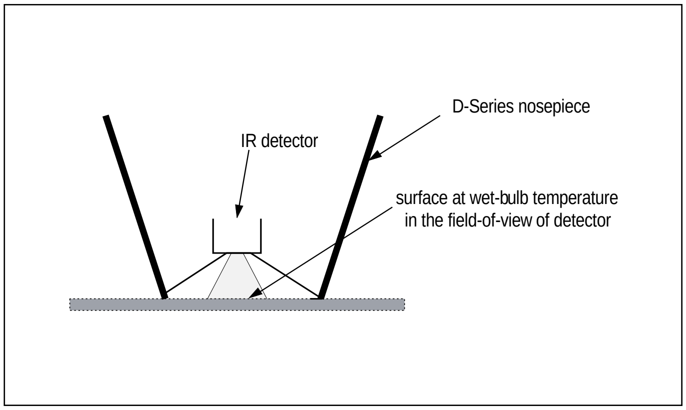
The accurate and reliable measurement of RH is one of the most challenging tasks in industry, and has included devices such as chilled mirrors, lithium chloride cells, aluminum oxide sensors, capacitance polymer sensors, hair hygrometers, carbon hygristors, and a wide variety of technologies to meet the requirements. Calibration and certification has been even more difficult, due to the fact that most humidity measuring devices employ *indirect* methods and therefore have limited traceability.





The Infrared Psychrometry method with the D-Series is a direct application of the thermodynamics and mathematics that defines humidity: the D-Series is capable of measuring the true wet-bulb temperature accurately, and with the dry-bulb temperature, the RH can be computed to a very high accuracy via standard psychrometric equations. The process is as follows:

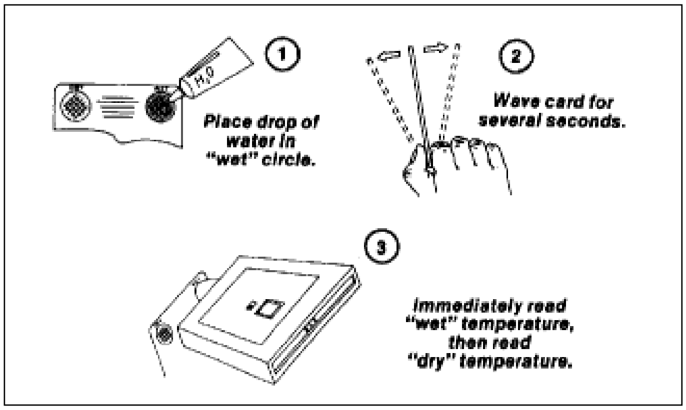
A porous material (filter paper is suitable) is wetted with water (purity is not important), and air from the environment flows across the surface to bring the surface to thermodynamic equilibrium with the air, i.e. to the lowest possible temperature produced by the evaporating water, which is the wet-bulb temperature.



The porous material, cooled on both sides by evaporating water, reaches wet-bulb temperature throughout the material, thus maintaining wet-bulb temperature at the surface for several seconds after the air flow stops. Since the water is opaque to infrared wavelengths, in as thin a layer as .002 in. (.05 mm), and the D-Series is able to measure the temperature with a time constant of 0.1 seconds, an accurate measurement of the wet-bulb temperature is obtained. The same procedure is employed on a non-porous material to obtain an accurate dry-bulb temperature.

With the appropriate psychrometric equations, the RH is immediately calculated. Each D-Series is equipped with, as a standard accessory, an RH Kit, which includes a convenient card with the wet and dry materials, simple RH and Dewpoint calculator, and handy tube of water.

Maximum accuracy for RH measurement is obtained with the D-Series models measuring 0.1° resolution. Though the absolute accuracy of the D-Series is not 0.1°, the RH is most sensitive to wet-bulb depression, i.e. the difference between dry-bulb and wet-bulb temperature. In its differential mode, the D-Series is accurate to 0.1°, which translates to an RH accuracy of approximately 0.5% for the normal range of RH.



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D-Series Handheld IR Scanners Specifications

Model	D501	D1001	D1201	D1601
Temperature Range	-50 to 550F & -45 to 287C	0 - 1000F & -18 to 540C	186 - 1207F & 86 to 653C	186 - 1600F & 86 to 871C
Relative Humidity Measurement	Kit Included	Kit Included	No	No
Emissivity Adjustment	Automatic Emissivity Compensation System			
Calibration Requirement	None			
Linearity Error	+/-1% of Reading - maximum			+/-3% maximum
Emissivity Error	+/-1% maximum of Difference between target temperature and instrument temperature when touching, for emissivity of 0.8 to 1.0			
Repeatability	+/-0.1⁰F & +/-0.1⁰C			
Resolution	0.1⁰F & 0.1⁰C			
Display / Update	Bright LEDs at 10 times per second			
Response Time	80 msec approximately			
Field of View	1:1 (53° approximately)			
Minimum Spot Size	1/4 inch (6.4 mm) approximately			
Spectral Sensitivity	2 to 20 microns			
Analog Output*	1 Mv / of (1mV / ⁰C) Optional			
F/C Conversion	Yes	Yes	Yes	Yes
Remote Sensor**	Available on all models; standard on D1201 and 1601			
Instrument Operatinge Temperature	32 to 122⁰F (0 to 50⁰C)			
Battery Life	Approximately 5000 Readings from on 9V Alkaline Battery			
Dimensions	Main Case: 3 3/8 X 5 X 3/4” (8.5 X 12.5 X 2cm)			
Weight (Remote Sensor Version)	7 oz (.2 kg) 9 oz (.25 kg)			

*Optional Analog Output - Specify “AO” ex. Microscanner D501-AO

D1001,D1201, & D1601 = 1mV/⁰F (C)

**Remote Sensor - Specify Model “RS” ex. Microscanner D501-RS

Microscanner D501& D501RS

D501

D1001

D1201

D1601

CE

Consult factory or distributor for special duty models with special accuracies and temerature ranges for OEM and volume applications.

THROUGH THE LOOKING GLASS

the Story of Alice's Quest for Emissivity

"It's All Done with Mirrors!"

"What do I see when I look in my mirror?" asked Alice. "I see myself, of course."

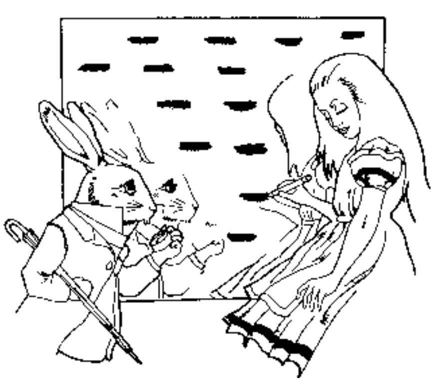
"But what about the mirror Why can't I see the mirror itself" she pondered. "Maybe it's because the mirror is invisible? Na, if it were, I would be able to see the wall behind it." Just then she had an idea, "I know, if I put spots of crayon on the mirror, then I can see the mirror!"

She put spots of crayon on the mirror and sure enough, she could see the mirror, wherever she put the spots! "The crayon spots are now part of the mirror, and I can see them!"

"Hmmmm . . ." she thought. "I still can't see the whole mirror. All I can see is the part covered by the spots. In between, I still see my face, not the mirror."

A magical white rabbit who had been watching Alice appeared and said, "Why, my dear girl, you are almost there! A little further and you will understand the concept of EMISSIVITY!"

"Emissivity?" queried Alice. "What is that?"



The rabbit, being patient as well as an expert on matters of light and heat, continued: "Alice. what do you see in your mirror?"

Alice replied, "Why. . . I see the mirror where crayon spots are, and my reflection where they are not."

"Of course." replied the rabbit. "You can see the visible part of the mirror, as crayon, but the rest, let's call it 'not-mirror: you cannot see because it REFLECTS.

"Does this mean that light bounces off the not-mirror part?" asked Alice.

"Why yes, of course, You are beginning to see it!" cried the rabbit. "What about the crayon marks? Does light bounce off them?"

"No!" said Alice. "I can see those for what they really are: the mirror itself and not my face."

"Splendid!" cried the rabbit. "Now, what if we counted up all your dots and added them together to see how much of the mirror they cover. Let's suppose that they added up to 10% of the mirror. What does that mean?"

"Hmmm . . ." said Alice, being thankful she always did her arithmetic homework. "That means that I can see 10% of the mirror!"

"And . . ," encouraged the rabbit.

"And that 90% is left for me to see my reflection?" cried Alice.

"Absolutely correct," stated the rabbit in his most authoritative voice. "Now you see a great principle—when you look at a surface, the sum of the amount you can see and not-see is 100%."

"And . . ," giggled Alice, anticipating his next statement. (You see, Alice is a very bright girl.)

"And . . ,"said the rabbit. "The part that you can not-see is replaced by a REFLECTION. What you see is not the object itself. The missing not-seen part is replaced by a reflection which can be seen! You see, Alice, nature insists that when you not-see something, you must see something else!"

"Wow!" thought Alice. "I wonder how Mother Nature knows when to do all this? She then asked. "What happens if I use more crayon and cover 90% of the mirror?"

"Why then, how much is left to reflect?" continued the rabbit.

"Of course," answered Alice, "only 10%."

'Nature insists on the total of the mirror and not-mirror adding up to 100%," explained the rabbit.

Suddenly, another thought struck Alice. "What if I wished to see all of the mirror? Would I then have to cover the whole thing with my crayon?"

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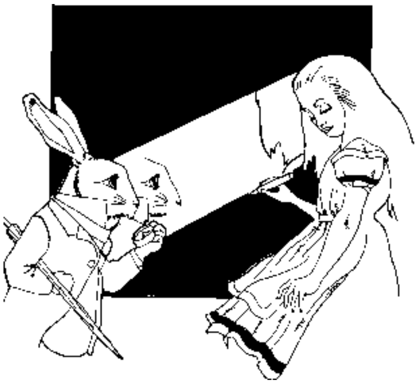


"That's one way," said the rabbit as if he read her thoughts. "But there is a better way, especially if you do not wish to disturb the mirror." Alice was puzzled, reasoning that to see 100% mirror, she would have to see 0% not-mirror, and not be able to see herself at all!

"It's all done with mirrors!" exclaimed the rabbit with a twinkle in his eye. He then produced a hollow, shiny, metal beach ball (proving white rabbits are not only smart, but magical) which he proceeded to divide in half, and put a small hole in the center of one of them.

"Why, it's a round mirror!" cried Alice as she peered inside it. "Right." said the rabbit as he placed it over the mirror with the crayon spots covering 10%. "Now look inside this hole, Alice, and tell me what you see."

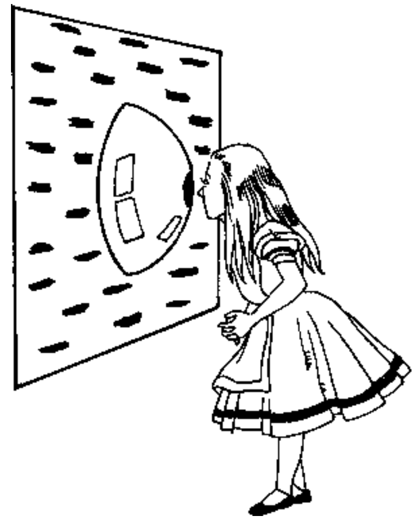
Alice carefully peered into the hole and gasped at what she saw. "I see all 100% as crayon!" she cried.

Not believing her eyes. she quickly removed the beach-ball half and looked at the mirror. It was the same as it was before! Ninety percent was reflecting the light from her face, while 10% was covered with crayon dots. Carefully replacing the beach-ball-half on the mirror and looking inside again, she insisted, "You must be using your magic to do this."

"No," said the rabbit softly. '"It is the nature of things which makes you see 100% mirror now, when there is only 10% of the mirror visible without the beach-ball-half."

"The 90% of the mirror which is reflecting is continuing to reflect. However, the light which it reflects has as its source only the crayon dots. The light from the crayon dots is reflected by the beachball-half BACK to the mirror. If the light happens to hit a reflecting part, it reflects BACK to the beach ball again, and back to the surface. Eventually the light hits a crayon dot. Then it is absorbed and does not reflect.

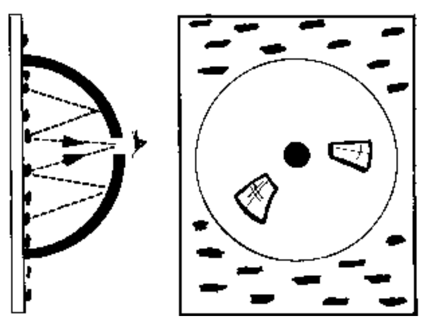
"When you look inside the hole, you see the result of zillions of reflections and absorption's of light. The entire reflecting part of the mirror is covered, not by the crayon dots themselves, but by the REFLECTIONS OF THE CRAYON DOTS!



"And that is why, my dear Alice, you see 100% of the crayon/mirror and 0% of anything else. For when we reach 100% of something, we can have 0% of not-something." concluded the rabbit.

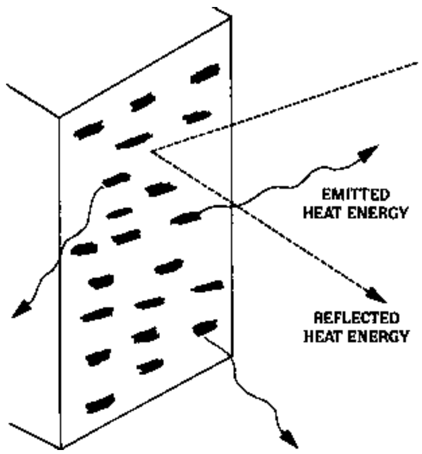
After a long pause, Alice asked, "What does all this have to do with EMISSIVITY? You said I was well on my way to understanding it."

"Well' said the rabbit. "Light energy and heat energy are identical. Both follow the very same rules. The difference is that heat energy, sometimes called INFRARED, cannot always be seen by your eyes. You can sometimes feel it, such as when you place your hand near a hot stove. Most of the time a sensitive instrument, such as a MICROSCANNER™, is required.



"All materials, like your mirror with crayon dots, will partly reflect and partly emit its own heat radiation. The part which is emitted because of its own heat is called EMISSIVITY. The part which is reflected from other objects nearby is called REFLECTIVITY.

"Just like your mirror with the dots, nature insists that the sum of EMISSIVITY and REFLECTIVITY is 100%. If a surface has an emissivity of .8, that means it emits



heat energy as if 80% of its surface were emitting at 100%. The remaining .2 reflectivity means that heat energy is reflected by 20% of the surface reflecting at 100%.

"So you see Alice, emissivity is not so mysterious. It is just the part of the surface that you can see, concluded the rabbit.

$$\left.\begin{matrix}\text{EMISSIVITY}\\ +\\ \text{REFLECTIVITY}\end{matrix}\right\} = 100\%$$

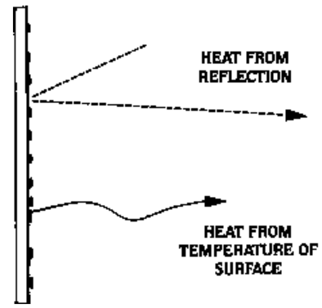
"I understand!" said Alice, "but what about the beach-ball-half with the shiny inside? How does that work in infrared?"

"Why that's a very, very good question, Alice." replied the rabbit, and he proceeded to explain.

"One of the purposes of using infrared is to measure the temperature of surfaces—much, much more quickly than can be done by other methods. However, there was a nagging problem of EMISSIVITY.

"The engineers at Exergen were gravely concerned with this problem, because their customers could not always know what the exact value of the emissivity is on any particular surface.

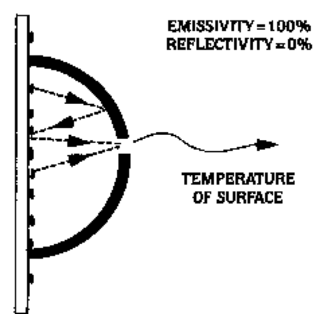
"You see, Alice, if a sensitive instrument is 'looking' at a surface, it sees, like your eyes do, a combination of



emitted and reflected heat radiation. Unless you know how many 'crayon dots' there are and what the reflections are, then you cannot know the temperature of the surface.

"What you really want to know, to get temperature, is the average heat emitted by the 'crayon dots: since they are really the surface. The reflective portion only tells you that the surface reflects—not what the surface is.

"Therefore, the Exergen engineers, in designing the MICROSCANNER D-SERIES, had a bright idea-use a shiny beach-ball-half! They called it the Automatic Emissivity Compensation System (AECS), a rather complicated name. Most people just call it a 'reflective cup'.



"You see, Alice, the shiny, reflective cup on the Dseries does the same thing that you saw in your mirror. Instead of your eyes, a sensitive detector is used to look into the hole.

"The heat emitted by the 'crayon dots' reflect and re-reflect until 100% of the surface is covered with the dots. Then the heat detector sees 100% dots and 0% not-dots. Therefore, the EMISSIVITY IS ONE.

"With the emissivity at 1.0, Alice, an exact temperature may be calculated by the electronic circuits in the MICROSCANNER D-SERIES." concluded the rabbit.

"Well, how about that!" said Alice. Now I understand emissivity, and also how to deal with it! If anyone ever asks how the MICROSCANNER D-SERIES works its magic, now I can tell them:

"IT'S ALL DONE WITH MIRRORS!"

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