

Chilling the Water Changes the Effect by Four Per Cent

— One litre removes 4.1860×10^4 J by temperature difference and 2.4500×10^6 J by evaporation, a factor of **58.53** — water at 5°C beats water at 25 by only **3.3882** per cent — and at 100 per cent humidity the effect is exactly zero — [Paper 464]

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— *From thinking to syncing.* —

Abstract

Sprinkling water is thought to work better cold. This paper shows that what cools is not the temperature of the water but its evaporation—a 20-degree change in water temperature moves the effect by **3.3882** per cent. No new theorem or law is claimed. First, one litre removes 4.1860×10^4 J by temperature difference (Section 2). Second, it removes 2.4500×10^6 J by evaporation, **58.53** times as much (Section 2). Third, this is the core of the paper. Water at 5°C beats water at 25 by only **3.3882** per cent (Section 2). Fourth, one litre evaporating cools 100 m³ of air by **20.3151** degrees (Section 3). Fifth, at 100 per cent humidity the cooling is exactly **0.000000000000** degrees (Section 3). Sixth, the separator is whether the cooling is sensible or latent (Section 4). **Keywords:** sprinkling water, latent heat, evaporative cooling, sensible heat.

Scope of this paper (scope note): No new theorem or law is claimed—the distinction between sensible and latent heat, the latent heat of vaporisation and evaporative cooling are all standard. No practice is recommended—when, where and how much to sprinkle is not the subject, nor are hygiene and safety. Air movement is excluded—where the cooled air goes is not the subject; a closed 100 m^3 is simply assumed. Evaporation rate is excluded—how fast the water evaporates is not the subject; only the heat once it has. Humidity is treated crudely—the evaporable fraction is taken as $1 - \text{RH}$; in reality it depends on the saturation deficit and air movement. Relation to earlier papers: Paper 463 showed that only a tenth of the geometric promise arrives—there too, the conspicuous quantity and the acting one differed. Paper 300 showed that common root and distinct root can be decided—“cooling by temperature difference” and “by evaporation” are distinct roots by that criterion. Paper 429 showed that the same air crosses the same height and comes out warmer—there too, latent heat held the answer. Paper 460 showed that the limit of heat is set with humidity—there too, humidity decided the room for evaporation. What is added is setting sensible against latent at 58.53, giving the effect of water temperature as 3.3882 per cent, giving the cooling of 100 m^3 as 20.3151 degrees, showing the linear dependence on humidity at four values, placing 100 per cent humidity as the boundary, and placing the separator at sensible versus latent.

1. Notation and the Question

Setting: A mass m of water removes, by a temperature difference ΔT (sensible heat),

$$Q_{\text{sens}} = m c_w \Delta T$$

and by evaporation (latent heat),

$$Q_{\text{lat}} = m L_v$$

Below, $c_w = 4186 \text{ J/(kg K)}$, $L_v = 2.45 \times 10^6 \text{ J/kg}$, one litre of water and ground at 30°C . Air is taken as $\rho_a = 1.2 \text{ kg/m}^3$ and $c_p = 1005 \text{ J/(kg K)}$.

Observation 1.1

Sprinkling water is thought to work better cold. Put something cold down and things cool—a natural thought.

Observation 1.2

But water evaporates. And in doing so carries off a great deal of heat without changing temperature—there are two routes.

Question: Which one is doing the work.

2. Latent Heat Is 58.53 Times Sensible

Computation 2.1: Take both quantities of heat for one litre.

Route	Heat removed [J]
Temperature difference (20°C water on 30°C ground)	4.1860×10^4
Evaporation	2.4500×10^6

Observation 2.2

Evaporation is **58.53** times larger. The temperature difference contributes 1.68 per cent of the total—evaporation alone accounts for almost all of it.

Computation 2.3: Vary the water temperature and take the total.

Water temperature	Total heat [J]
5°C	2.5546×10^6
25°C	2.4709×10^6

Observation 2.4

Twenty degrees of water temperature buy **3.3882** per cent. Iced water beats tap water by three per cent—not worth the trouble.

Observation 2.5

Latent heat is large because it is the work of breaking hydrogen bonds. Raising a temperature and changing a phase differ by orders of magnitude—the same word “heat” with different destinations.

3. One Litre Cools 100 Cubic Metres by 20.3151 Degrees

Computation 3.1: Take the cooling of 100 m³ of air by one litre evaporating.

20.3151 degrees.

Observation 3.2

Enough to move the air around a house. From one bucket—which is why sprinkling is felt at all.

Computation 3.3: Take the evaporable fraction as $1 - \text{RH}$ and tabulate the cooling.

Humidity [%]	Evaporable fraction	Cooling [°C]
30	0.70	14.2206
60	0.40	8.1260
90	0.10	2.0315
100	0.00	0.000000000000

Observation 3.4

At 100 per cent it is exactly zero. Not approximately, but identically in this model—with no evaporation, the latent route closes.

Observation 3.5

What remains is the sensible heat, 1.68 per cent of the total. Sprinkle on a humid day—and almost nothing happens.

Observation 3.6

The cooling is linear in humidity. The cooling at 60 per cent is exactly $\frac{4}{7}$ of that at 30—because it is proportional to $1 - RH$.

Observation 3.7

So whether sprinkling works is decided by humidity, not water temperature. 3.3882 per cent against everything from zero to a hundred—a wholly different range of influence.

4. The Separator

The separator: is the cooling sensible, or latent.

Observation 4.1

Sensible, and the temperature difference acts. Colder is better—and humidity is irrelevant.

Observation 4.2

Latent, and whether evaporation is possible acts. The water temperature hardly matters—and humidity is decisive.

Observation 4.3

These are distinct roots by the criterion of Paper 300. Both are called “cooling with water”—one a quantity of temperature difference, one of phase change.

Observation 4.4

This stands where Paper 429 stands. There, the same air crossed the same height and came out warmer, and latent heat held the answer—it holds the answer here too. Phase change carries heat that does not show in a temperature.

Observation 4.5

It overlaps Paper 460 as well. There, humidity decided the room for evaporation—here it decides whether sprinkling works. The same mechanism acts on a person and on the ground.

Observation 4.6

And on Paper 463. There, the conspicuous quantity (torque) and the acting one (clamp force) differed—here the conspicuous one (water temperature) and the acting one (room to evaporate) differ.

Observation 4.7

To be honest—humidity is treated crudely. The evaporable fraction was taken as $1 - RH$, whereas in reality it follows the saturation deficit and air movement—the value 14.2206 depends on that model; the conclusion that it is zero at saturation does not.

5. Roll Call and Closing

1. Sensible is 4.1860×10^4 J (Computation 2.1): **the temperature route.**
2. Latent is 2.4500×10^6 J (Computation 2.1): **58.53 times.**
3. Sensible is 1.68 % of the total (Observation 2.2): **almost all evaporation.**
4. Twenty degrees buy 3.3882 % (Observation 2.4): **the core.**
5. 100 m^3 by 20.3151 degrees (Computation 3.1): **from one bucket.**
6. 14.2206 degrees at 30 % humidity (Computation 3.3): **dry air works.**
7. 0.000000000000 at 100 % (Observation 3.4): **identically zero.**
8. Linear in humidity (Observation 3.6): **4/7 exactly.**

9. The separator is sensible or latent (Observation 4.3): distinct roots by Paper 300.

10. Humidity is treated crudely (Observation 4.7): the zero survives.

Closing: Sprinkling water is thought to work better cold—put something cold down and things cool, a natural thought. But water evaporates, and in doing so carries off a great deal of heat without changing temperature. There are two routes. The two routes differ enormously in size—one litre removes 4.1860×10^4 J by temperature difference and 2.4500×10^6 J by evaporation, a factor of **58.53**. The temperature difference contributes 1.68 per cent of the total. So a 20-degree change in water temperature, from 5 to 25, moves the total from 2.5546×10^6 to 2.4709×10^6 J, a difference of **3.3882** per cent. Iced water beats tap water by three per cent, which is not worth the trouble. Latent heat is large because it is the work of breaking hydrogen bonds: raising a temperature and changing a phase differ by orders of magnitude, the same word “heat” with different destinations. The effect is large, provided evaporation can happen—one litre evaporating cools 100 m^3 of air by **20.3151** degrees. One bucket moves the air around a house that far, which is why sprinkling is felt at all. But taking the evaporable fraction as $1 - \text{RH}$, the cooling is **14.2206** degrees at 30 per cent humidity, 8.1260 at 60, 2.0315 at 90 and **0.000000000000** at 100. At saturation it is not approximately but identically zero: with no evaporation, the latent route closes, and what remains is the sensible 1.68 per cent. The cooling is linear in humidity, with 60 per cent giving exactly 4/7 of 30. So whether sprinkling works is decided by humidity and not water temperature—3.3882 per cent against everything from zero to a hundred. One thing separates them—is the cooling sensible, or latent. Sensible, and the temperature difference acts: colder is better and humidity is irrelevant. Latent, and whether evaporation is possible acts: the water temperature hardly matters and humidity is decisive. They are distinct roots by the criterion of Paper 300, one a quantity of temperature difference and one of phase change. This stands where Paper 429 stands, where the same air crossed the same height and came out warmer with latent heat holding the answer. Phase change carries heat that does not show in a temperature. It overlaps Paper 460 too, where humidity decided the room for evaporation: the same mechanism acts on a person and on the ground. And Paper 463, where the conspicuous quantity and the acting one differed: here it is water temperature against room to evaporate. To be honest—humidity is treated crudely. The evaporable fraction was taken as $1 - \text{RH}$, whereas in reality it follows the saturation deficit and air movement. The value 14.2206 depends on that model; the conclusion that it is zero at saturation does not.

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