Save water in water distillation systems in laboratories

Munnalal et al.[1] seem to be overly concerned with what they call 'the efficiency of the condensing unit', and also with the quantity of water 'flowing down the drain', which they estimate to be '800–1000 litres for every 10 litres of distilled water'. This estimate itself could be wrong for at least two reasons. First, the standard practice for water distillation in laboratories is to maintain just enough water flowing through the condenser to keep the distillate as hot as possible without going off as steam: the high temperature of the distillate results in better quality of the distilled water, especially because there is less of dissolved gases. This practice does not lead to any significant lowering of the efficiency of condensation. Second, part of the hot water flowing out of the condenser is usually fed back into the distillation vessel through a constant-level device built into the vessel: this practice saves energy (electricity or gas) needed for boiling the water. If one chooses, water overflowing from the constant level device can always be collected and reused. Therefore, there is little unnecessary wastage of water. The 'perforated disk' contraption designed by the authors would actually result in wastage of energy. One should be more concerned about this wastage than water going down the drain.

It may be pointed out that de-ionized water can usually serve as a substitute or even as a better option than 'distilled' water in many laboratory procedures. Even tap water will do for many purposes. Using distilled water when it is not needed is similar to using 'Whatman No: 42' filter paper where 'Whatman No: 1' or even a blotting paper is adequate, or using 'analytical grade' sucrose for sweetening your tea. The scientists have to use their knowledge, discretion and sense of responsibility.

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1. Munnalal et al., Curr. Sci., 2008, **95**, 438.

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Response:

Our estimate of the tap water that flows through the drain in most commonly used distillation units (glass or steel distillation units) is based on actual measurements on several such units in different laboratories/departments of our university. Very few laboratories actually control the tap water precisely to the minimal level required. However, even in these cases, the water flowing through to the drain in about 8 h of operation would still be at least 500 l.

Most of the distillation units do not have a provision for the water flowing out of the condenser to feed the boiling water container. Even if it does, only a small part is actually reused with the rest flowing out to the drain and thus wasted.

The only additional recurring energy (less than 50 W) used in the 'contraption' described by us is that required to run the water circulating pump. We believe that saving 500 l of water from going down the drain is more sensible than not using this little extra energy!

We agree that de-ionized water can be a good substitute for distilled water in some, but not in all, cases. Tap water can be used only for routine washing. However, a more stringent washing of glassware, etc. needs final rinses with distilled water to get rid of the contaminants that are invariably present in tap water. Preparation of a solution even for school or UG or PG classes requires pure or distilled water, if the students have to be properly trained. Further, deionizers involve their own recurring costs and to prolong their lives, distilled water is often preferred to be used in deionizing units in laboratories.

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Sanakanika inscription and the summer solstice

This refers to Chandra Hari's historical note[1] on the subject regarding the passage way at Udayagiri.

The authors of the earlier historical note[2] are right in their observation that the direction of the rising sun at the place of lat. 23°31′N on the day of summer solstice is 25°56′, the sun's azimuth being about 64°.064855. The Sanakanika inscription mentions its lunar calendrical date as Ashadha shukla ekadashi of the regnal year 80. Sharan and Balasubramaniam mention this date as equivalent to 26 June 402 AD.

Chandra Hari's conclusion that the date 26 June 402 falls in the month of Sravana and not Ashadha is incorrect! In fact, in table 1, under the 'Remarks' column, the author takes the dates of three successive fullmoon days, viz. 402/05/03, 402/06/02 and 402/07/01 as the middle of the lunar months Vaishakha, Ashadha and Sravana. In the process, he has skipped the Jyeshtha month between Vaishakha and Ashadha. In fact, the year 402 AD had neither an adhika masa nor a kshya masa (i.e. no intercalary months). Thus, the date 402/06/02 corresponds to the fullmoon day in the lunar month of Jyeshtha. On the other hand, 402/07/01 was the fullmoon day of Ashadha and not of Sravana, contrary to Chandra Hari's contention. But, the author's argument that 26 June 402 was a dashami (tenth day of the bright fortnight) and that the next day, i.e. 27 June was an ekadashi is correct. However, apparently the author's computations are based on modern formulae, while during the period about 16 centuries ago, some ancient traditional astronomical system (pre-Aryabhatan) was in vogue. The parameters

were obviously different from what we get by modern computations. Therefore, an error of several hours in computing the soli-lunar days (*tithis*) is not unusual.

Throughout his article, Chandra Hari mentions the sun's rising exactly in the east on the day of summer solstice! Obviously, this is incorrect. The sun rises exactly in the east, for a non-equitorial place, only on the two equinoctial days and not on the solsticial days.

In conclusion, the date of the Sanakanika inscription must be 27 June 402 AD (Julian) and not in the month of May.

1. Chandra Hari, K., *Curr. Sci.*, 2008, **95**, 117–124.
2. Sharan, M. A. and Balasubramaniam, R., *Curr. Sci.*, 2004, **87**, 1562–1566.

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Summer solstice and Udayagiri

Chandra Hari[1] has discussed the astronomical significance of the cave at Udayagiri in great detail. However, there seems to be some confusion about the direction of the rays of the rising sun on summer solstice. As has been shown in the context of the Vidyashankara temple in Sringeri[2], the direction of the rising sun may be calculated from the formula

$$\sin \delta = \sin \phi \sin a + \cos \phi \cos a \cos A, \quad (1)$$

where δ is the declination of the sun, a the altitude, ϕ the latitude of the place and A the azimuth. Using the fact that at the time of rise (and set) a is zero, the azimuth is calculated as the direction of the rising sun.

The direction has been observed by Sharan and Balasubramaniam[3] to be 25°56′. This fits exactly into eq. (1) for a latitude value of 23°31′ for the date of summer solstice. It should be noted that

neither 29 May nor 22 June satisfies this requirement for CE 402. It is well known that owing to the precession of equinoxes, the date of solstices has been shifting gradually. In fact, this was responsible for the reformation of calendar 400 years ago. Thus an extrapolation from today naturally leads to some discrepancies, which can be accounted for. Hundreds of stone inscriptions with the dates of solstices have been identified all over India and their study corroborates with the gradual shift of solstice dates. Thus the date was around 25 June in the 11th century and therefore 26 June as the date for CE 402 is not unrealistic. Moreover, the type of small differences in the declination of the sun as depicted in table 4 of the paper can be observed only after compiling the data over several decades. Solstice is an event and not a day. Thus some margin should be allowed depending on whether the solstice occurred at noon or some other time of the day. For example, in the year 2008 the solstice occurred at 05:29 am IST and therefore, the noon shadow would not reflect the exact event. However, any such architectural plan will incorporate a finite margin so that about a week on either side of the solstice, the rays of the sun enter the cave, as in the case of the Gavi Gangadhareshwara Temple in Bangalore[4].

The paper mentions about the sun rising exactly at the east on the day of Sanakanika inscription, which cannot be true. As is well known the sunrise at the exact point east happens only on the days of equinoxes all over the globe. This can also be deduced from eq. (1) by putting $\delta = 0$. The paper mentions that on summer solstice the earth is nearest to the sun. The situation is the opposite – the aphelion passage occurs on 4 July every year.

The observation by Balasubramaniam and Dass[5] that the shadow near the south wall disappears on summer solstice at noon is a simple extension of the eq. (1). At meridian transit the value of A is 180°/0°. Then, eq. (1) simplifies to

$$\sin \delta = \sin \phi \sin a. \quad (2)$$

The disappearance of the shadow implies that $a = 90°$ or that $\delta = \phi$. This is true for CE 402 and any other year. In fact, observing the noon shadow on solstice was and is one of simplest methods of finding the latitude of a place.

In light of the above simple explanation, the lengthy discussion on the min-

ute variation of declination and the discussion based on sunrise at 'exact' east point are uncalled for. Likewise, the second part of the paper and appendix throw no light on the Udayagiri architecture. The appendix completely ignores the fact that Manasara gives a rule to apply correction for the change in declination of the sun within a day. There was no assumption that the sun remains 'stationary' for 21 days.

1. Chandra Hari, K., *Curr. Sci.*, 2008, **95**, 117–124.
2. Shylaja, B. S., *Curr. Sci.*, 2007, **92**, 846–849.
3. Sharan, M. A. and Balasubramaniam, R., *Curr. Sci.*, 2004, **87**, 1562–1566.
4. Jayanth Vyasanakere, P., Sudeesh, K. and Shylaja, B. S., *Curr. Sci.*, 2008, **95**, 1632–1636.
5. Balasubramaniam, R. and Dass, M. I., *Curr. Sci.*, 2004, **86**, 1134–1142.

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Response to comments from
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(i) 'The authors of the earlier historical note are right in their observation that the direction of the rising sun at the place of latitude 23°31′ on the day of summer solstice is 25°56′ . . .'.

Nobody will dispute the result of a basic equation like the one quoted by Sharan *et al.* and I have given reference to that:

$$\sin \delta = \sin \varphi \times \sin h + \cos \phi \times \\ \cos h \times \cos A.$$

At a place of latitude 23°31′, can the direction of 25°56′ be due east, when the azimuth will be 64.06?

Azimuth has to be $90 - \phi$, i.e. 90-latitude and those who had the date of the Sanakanika inscription fixed had this knowledge and the observational skill to make out that the sun rose due east on āsāḍha śukḷa ekādaśī of the year 402 AD, which fell on 29 May 402 AD.

(ii) 26 June 402 AD in *Śravana*.