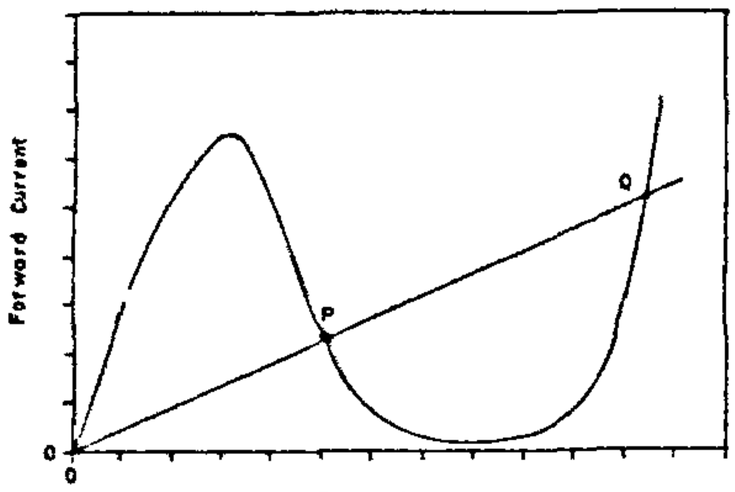

Figure 3. Forward characteristic of a tunnel diode.

measurements are quite reliable and are comparable in accuracy to the measurements obtained by the usual methods. One advantage of this method over the standard method is that here we can measure current over a wide range, spanning at least 3 orders of magnitude which is not easily available with commercial instruments.

In summary, we see that the diodes give stability to the output voltage at a given temperature and a rationale for finding it. On the other hand, if the output voltage is known we can find the diode characteristic curve. The analysis finds an important upper limit for R_3 for a given R_1 and R_2 for which the output voltage of the oscillator is stable. If instead of diodes we use tunnel diodes for the stabilization an interesting situation may arise. The tunnel diode has a characteristic as shown in Figure 3. The straight line intersects the characteristic curve at two points apart from the origin. So there is a possibility for a system with two stable solutions. This may be a very interesting subject matter for further study.

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Are sperm counts declining?

Many reports suggest that sperm counts in men have steadily declined over the last fifty years from 113 million sperms per ml in 1940 to a low of 60 million sperms per ml in 1990 (refs 1 and 2). The reason for this decline was attributed to chemical pollutants with estrogenic effects[3]. Fears have even been expressed that in the next millennium procreation may have to depend heavily on assisted reproduction. But there have been a few reports denying declining sperm counts[4,5]. What is more population figures show an upward trend specially in the developing countries. Reports on sperm counts from India appear to be scarce[6–8] and thus a confident conclusion is difficult.

Infertility Institute and Research Centre (IIRC), Secunderabad has been routinely performing semen analysis since mid-1992 adhering to the guidelines recommended by WHO. The present report is a retrospective look at the semen profiles of 1855 men who were the male partners of couples seeking treatment for infertility. These men were divided into 4 batches, A, B, C and D between August, 1993 and March, 1998 with intervals of 6, 18 and 5 months between the batches. Though the men come from a group attending an infertility clinic, the data need not be considered biased since if anything this group of men should show a decline in sperm count rather than an increase. The three other Indian studies cited also come from infertility clinics[6–8].

The fluctuating average counts in the four groups of men do not support a declining count hypothesis (Table 1). An earlier report did demonstrate a decline in sperm concentration from 69 to 43 million sperms per ml between 1992 and 1996 (ref. 7). Recently Gopalkrishnan[8] also demonstrated that sperm count in Indian men declined from 65.71 to about 30 million per ml from 1986 to 1992.

Table 1. Characteristics of semen samples from 1855 men during 1993 to 1998

	Year of semen collection			
Characteristics	Batch A August, 1993–August, 1994 ($n = 641$)	Batch B February, 1995–July, 1995 ($n = 425$)	Batch C January, 1997–July, 1997 ($n = 500$)	Batch D January, 1998–March, 1998 ($n = 530$)
Age of individual	32.3 ± 5.3^a	33.1 ± 5.5^a	32.1 ± 4.9^a	33.2 ± 5.7^a
Semen volume	2.3 ± 1.9^a	2.1 ± 1.3^a	2.2 ± 1.1^a	2.5 ± 1.4^a
Sperm concentration ($\times 10^6$ per ml)	49.8 ± 43.4^a	34.8 ± 31.0^b	53 ± 47.4^a	50 ± 43.5^a
Sperm motility (%)	47.0 ± 15.2^a	53.6 ± 19.5^a	45.5 ± 26.9^a	48 ± 23.9^a
Morphologically normal spermatozoa (%)	43.7 ± 21.5^a	29.3 ± 13.8^b	22.1 ± 16.8^c	23.9 ± 13.4^d

Values are expressed as mean ± standard deviation. Different superscripts in each line indicate that the means are significantly different ($P < 0.01$) as determined by Student's t-test.

But, subsequently no significant decrease in sperm count was observed after 1993 as observed in the present study. In fact, it is intriguing to note that the semen count showed a marginal increase between 1986 to 1989 preceding the sharp decline between 1989 and 1992 (ref. 8). The reason for this fluctuating trend is not known but since all the samples analysed were from the same institute the author rules out the possibility of variation in methodology and other factors related to laboratory practice[8]. In the present study, the sudden significant decrease in 1995 is also hard to explain and it is definitely not due to change in methodology or due to any other artifact. The observed discrepancy with regard to decrease in sperm count as observed by Mehta and Kumar[7] and Gopalkrishnan[8] and lack of decline in the present study may reflect a feature characteristic of the three populations studied which belong to different geographic loactions. Further, the sample size and the duration of study in the present investigation were comparable to the study by Mehta and Kumar[7] but differed from the study by Gopalkrishnan[8] in which the sample size was small but the duration was longer. Thus the present study should have been more similar to the work of Mehta and Kumar but it appears to have more similarities with the work of Gopalkrishnan[8]. This further strengthens our view that geographic locations are important so as to make conclusions on semen analysis of populations. The present study also differs from the earlier studies with respect to duration between the compared samples but this may not be responsible for the discrepancy since in the present study irrespective of whether the duration was 6 months or 18 months all parameters showed a similar trend. However, occupation of the subjects could have been an important parameter[7].

The other semen parameters such as volume and percentage of sperm motility also did not show any significant changes, thus confirming a recent report[7]. It was also observed that the semen volumes reported by us (2.1 to 2.5 ml) were significantly lower than that observed in an earlier Indian study[7] but were comparable to the recent Indian study[8] and two European reports[1,9], which showed that by 1990 the volume was around 2.75 ml. The most significant change observed in the present study was a decline in the number of morphologically normal spermatozoa by 45% between 1993 and 1998 as observed earlier by Auger *et al.*[9]. Gopalkrishnan[8] also observed that sperms with normal morphology decreased by 30% between 1986 and 1996. However, Mehta and Kumar[7] did not observe any decrease in the number of normal spermatozoa. Thus the present study confirms the recent observations of Gopalkrishnan related to decrease in percentage of normal spermatozoa and with respect to absence of any change in percentage of sperm motility and mean semen volume. But, unlike both the Indian reports[7,8] a continuous decline in sperm count was not observed. The reasons for this discrepancy is difficult to address since many factors such as incidence of congenital abnormalities of male reproductive system, level of pollutants, extent of industrialization, geographic locations and occupation of the individual influence semen profiles.

In conclusion, it appears that in order to assess semen quality changes in the Indian population it would be necessary to extend the study to a number of regions, to include as many subjects as possible and to extend the analyses to a longer period of time.

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