



# XLIX. On Mr. Dalton's speculations respecting the mixture of gases, the constitution of the atmosphere, &c.

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**XLIX.** *On Mr. DALTON's Speculations respecting the Mixture of Gases, the Constitution of the Atmosphere, &c.* By THOMAS TREDGOLD, Esq.\*

**I**T appears that Mr. Dalton's speculations respecting the mixture of gases and vapours, and the nature of the atmosphere, have been very generally received as true explanations of the phenomena of the one and of the nature of the other; and by those who are considered of high authority in science.

Under these circumstances, it becomes the duty of those who reject these speculations as erroneous, to exhibit the grounds on which they do object to them, in the hope that the true explanation of these important points of physical science may be established.

We owe much to Mr. Dalton, even in cases where he has not been successful, and his name will always be respected by those who feel any interest in the progress of knowledge; and I am sorry that I have to oppose as inaccurate one of those bold speculations on which much of his fame has been raised.

If his had been merely speculations, and without influence on the progress of other branches of physical inquiry, they might have remained unopposed; but when formulæ for the reduction of chemical experiments to a common standard are founded on them, and they are made the basis of other theories, and are used in the correction of barometrical measurements, and in various meteorological inquiries, it becomes a work of necessity to examine how far these doctrines are founded in truth.

When Mr. Dalton's opinions first appeared, they were opposed by Mr. Gough, and with sufficient force to have called for more accurate investigation before they were acceded to. Mr. Gough's paper was however not satisfactory to me; and as far as I can recollect, it was very diffuse.

The whole of Mr. Dalton's theory rests upon a very im-

\* Communicated by the Author.

portant proposition in aërostatics: for if this proposition be true, the whole of his speculations are at variance from it, and must, therefore, be erroneous. Consequently, the labour of refuting them is reduced into a very narrow compass.

**PROPOSITION I.**—If an uniform mixture of gases or vapours, which mix without condensation, be confined in a close vessel, the elastic force of each gas on a given surface must be the same, and equal to the elastic force of the mixture on the same extent of surface.

Let  $p$  be the elastic force of the mixture, and  $V$  the volume of the vessel. Also let  $A$  and  $B$  be the two gases, and  $v$  the volume of the gas  $A$  when its elastic force is  $p$ .

It is obvious, that  $v$  must be less than  $V$ , otherwise the gas  $A$  would entirely fill the vessel, and a mixture could not be formed without condensation.

But since  $v$  is less than  $V$ , and the gas  $A$  is uniformly distributed throughout the greater volume of the vessel  $V$ , its parts must be kept asunder by a force which is not less than its own elastic force; and as the force which keeps separate the parts of the gas  $A$ , is the elastic force of the gas  $B$ , therefore, the elastic force of the gas  $B$  in the mixture cannot be less than that of  $A$ .

But by the same steps it may be proved that the elastic force of the gas  $A$  cannot be less than that of  $B$ , and consequently, that their elastic forces must be equal in the mixture, and also equal to the elastic force of the mixture.

The addition of two other propositions will not only give the means of comparing the result of the preceding one with experiment, but also give the formulæ which will supply the place of Mr. Dalton's.

**PROPOSITION II.**—If given volumes  $V, v$ , of gases of different elastic forces  $F, f$ , be allowed to mix and occupy the volumes which previously contained them, the elastic force of the mixture will be equal to  $\frac{VF + vf}{V + v}$ .

Let  $p$  be the elastic force of the mixture: and since it has been proved that each gas taken separately must be of the same elastic force as the mixture, and the volumes are inversely as the elastic forces, we have

$\frac{1}{f} : \frac{1}{p} :: v : \frac{vf}{p}$  = the volume of the gas whose elastic force was  $f$  before mixture; and consequently,

$V + v - \frac{vf}{p} = \frac{p(V + v) - vf}{p}$  = the volume to be occupied by the other gas. Hence

$$\frac{1}{V} : \frac{p}{p(V + v) - vf} :: F : p = \frac{Vrp}{p(V + v) - vf}, \text{ or } \frac{VF + vf}{V + v} = p.$$

*Cor.*

*Cor. 1.*—When the volumes before mixture are equal  $\frac{F+f}{2} = p$ ; or the resulting elastic force is the mean between the elastic forces before mixture.

*Cor. 2.*—If  $F = f$ , then  $F = p$ , or the elastic force, is not changed by mixture.

PROPOSITION III.—If given volumes  $V, v$ , of gases or vapours of different elastic forces  $F, f$ , be mixed, and the elastic force of the mixture be  $p$ , then  $\frac{VF + vf}{p} =$  the volume of the mixture.

For, by Prop. 1, the elastic force of each gas is to be equal to the elastic force of the mixture, and therefore

$\frac{1}{F} : \frac{1}{p} :: V : \frac{VF}{p} =$  the volume of the gas whose force before mixture was  $F$ ; and

$\frac{1}{f} : \frac{1}{p} :: v : \frac{vf}{p} =$  the volume of the gas whose force was  $f$  before mixture: hence, the volume of the resulting compound is  $\frac{VF + vf}{p}$ .

*Cor.*—When  $V = v$ , and  $F = p$ , we have  $\frac{V(p+f)}{p} =$  the volume after mixture.

This condition, viz. that  $V = v$ , seems to apply with accuracy to the combination of air with the vapour of water, when the air is saturated. Mr. Dalton arrives at the formula  $\frac{Vp}{p-f} =$  the volume; and to put the two to the test, let an experiment be made when  $f$  is equal to  $\frac{2}{3}p$ .

By Mr. Dalton's formula, the volume of the mixture of air and vapour would be three times the volume of the dry air.

By my formula the volume of the mixture of air and vapour would be only  $1\frac{2}{3}$  of the volume of the dry air.

I did intend to conclude here; but I cannot resist the temptation to ask Mr. Dalton, or M. Gay-Lussac, how in a mixture of one part of dry air of an elastic force of 30 inches of mercury with 2 parts of vapour of the elastic force of only 20 inches, the whole mixture should possess an elastic force of 30 inches? If they can answer this question satisfactorily, we need not altogether despair of a perpetual motion being discovered. But to be once again serious: I shall be very happy to have any error in my train of reasoning or results pointed out, should such be detected by any of your learned contributors.

16, Grove Place, Lisson Grove, May 2, 1826.

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