

An account of the increase of Weight in Oyl of Vitriol expos'd to the Air.

Since the Excellent *Mr. Boyle* has made the *Air* a Subject of his Observations, the Learned World is sufficiently taught how vast a share it has in producing many *effects*, which Philosophy never so much as dream'd of before; and if, upon the hint experiment has given us, we reflect on the infinite variety of *steams* constantly emitted from all sorts of Bodies into the *Atmosphere*, which are there *dissolv'd* as it were in a common *Menstruum*; we have reason to expect therein *particles* enough of all *shapes, sizes* and *motions* fit and proper to alter the *texture, diminish* or *increase* the *Bulk* and *weight*, of almost any *body* expos'd to its action.

As to the *Increase* of *Weight* (the business in hand) we know how bodies Rob'd of some constituent parts by fire (*as quicklime and all calxes*) slacken and greedily imbibe something from the *Air*; and the like is observ'd in the *caput mortuum*, of *Salt, Nitre, Alum* and *Vitriol*. On the same score all *fixt Salts* run into a fluid *per deliquium*; 'Tis the *Air*, that in *seven years* fully reimpregnates the earth heap't up in the shade whence *Nitre* was before extracted; 'tis the *Air* that causes the *Efflorescence* of *Marcasites* and *Vitriol-stones*; 'tis the *Air* that by its *acid* turns the *lead* of old buildings into *Cerusse*, which without doubt increases in *Weight*, (as that made by fire does) which is asserted to be at the rate of six or seven pound in an hundred. The same *Growth* of *Metals* seem to acknowledge the same origine, and there are *none* (*Gold* it self not excepted) but what *Agricola, Gerhardus* and some other *Metallick Writers* observe to have *increas'd* considerably by the free access of *Air* to the *Shafts* and *Groves*; and the very heaps of *Rubbish* wash't from *Tin Oar's* here in *England* have within the memory of man, nay in 10 or 12 years been wrought over again with great advantage:

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now though we must perhaps acknowledge in some of these Instances, that the particular *seminal principle* specifies these new acquir'd parts; and determinately makes them *Mineral* or *Metallick* of the name and nature of the *Matrix* into which they are received, yet this is certain; the addition of *weight* is owing to a *Substance* communicated by the *Air*. *Instances* of this nature concerning the *growth* of Lead, Iron, Tin, Silver and Gold with the *Increase* of other bodies are succinctly collected and with his *wonted Sagacity* remarkt on by Mr *Boyle* in his tracts on that subject. So that the *Increase* and *attractive power* of *Solids* is a Theme already fairly cultivated and put beyond question: But that *liquids* such as seem *Saturated* with their *own moisture* should neverthe'efs imbibe *more* from the *Air* is not mentioned by any Author I know of, except the *aforesaid Learned person*, who in his Tract of *Aerial magnets* advices tryals upon the *liquid preparations* of *Vitriol*: I have heard indeed some Druggists have accidentally taken notice of this encrease in *Oyl* of *Vitriol*, (and perhaps have improv'd it to their *own gain* though *to the detriment* of the buyer,) but the observation never was profecuted with any method or certain account how much the said *Increase* was, and *what the substance, gain'd*.

The Industrious Chymist Mr. *White* our University Operator, having a *Viol* of that liquor *unstopt* and constantly *running over*, first gave occasion to the following notes: but since from thence no true estimate of the just *Increase* could be collected, I hope it may not prove altogether ungrateful to the *Curious* to give you, in answer to your request, what has occur'd more particularly on this subject, and I do it the more readily because the *R. S.* have thought it a thing not *to little* for the press.

On the ninth of No. 1683. Three Drams of *Oyl* of *Vitriol* so far *Dephlegm'd* as to burn or *Corrode* a strong pack-

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thred, affunder, was *expos'd* to the *Air* in a *Marmalade*
Glas of *three Inches*. Diameter, and plac't in a nice
pair of Scales, in a Room where no fire nor Sun came;
Its *Increase* for *7 natural days* divided by *lefs* portions of
time was according to the following Table.

A T A B L E

A TABLE.

D. Hour. Gain. Space of time. Weath. Wind. Sum of gain. Natural Day.

D.	Hour.	Gain.	Space of time.	Weath.	Wind.	Sum of gain.	Natural Day.
9	5 pom.	Dr. 0	Scr. 0	Gr. 19	H. 6	Moist, Moist & Windy,	Southerly. N. Westerly.
	11 pom.	gain 0	0	19	6		
	8 mat.	1	12	9	9	Rainy Morn.	
	11 mat.	0	8	3	6	Clear.	
10	5 pom.	0	9	6	6	Starlight, Cold.	N. W.
	11 pom.	0	18	6	6	Bright Morn. mild.	
	8 mat.	1	07	9	9	Mild dry weather.	
	11 mat.	0	4	3	6		
11	5 pom.	0	9	6	6	Mild dry clear Morn. Frothy.	N. W. North. N. more West.
	11 pom.	0	10	6	6	Overcast	
	8 mat.	0	17	9	9		
	11 mat.	0	5	3	6		
12	5 pom.	0	7	6	6	Cloudy Rain	Vesterly. Southwest.
	11 pom.	0	6	6	6	Cloudy mild.	
	8 mat.	0	9	9	9	Cloudy moist	
	11 mat.	0	3	3	6	Cloudy misty Mitty	
13	5 pom.	0	5 $\frac{1}{2}$	6	6	Very Warm.	Southeast. Southerly.
	11 pom.	0	6	6	6	Cloudy un- usually warm. Cloudy.	
	8 mat.	0	8	9	9	Cloudy moist.	
	11 mat.	0	2 $\frac{1}{2}$	3	6	Clear Coldish.	
14	5 pom.	0	1 $\frac{1}{2}$	6	6	Dry Starlight Cold. Cloudy but Cold	more South South East more South Easterly. Easterly. Southeast.
	11 pom.	0	6	6	6	Cloudy Windy	
	8 mat.	0	6	9	9	Cloudy very mild.	
	11 mat.	0	3	3	6		
15	5 pom.	0	4	6	6		Scr. Gr.
	11 pom.	0	2	6	6		
	8 mat.	0	6	9	9		
	11 mat.	0	3	3	6		
16	5 pom.	0	2	6	6		Scr. Gr.
	11 pom.	0	4 $\frac{1}{2}$	6	6		
	8 mat.	0	9	10	10		
	11 mat.	0	2	2	6		

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From the 16th. in the successive spaces of twenty four hours, each gain'd one of the number of Grains following, as the 8th. natural day gain'd $13\frac{1}{2}$, the next 12, 9, 7, 6, 5, 5, $4\frac{1}{2}$, 3, 3, 3, 3, 4, 3. (*December*) 4, $4\frac{1}{2}$, 4, 3, 3, &c. still irregularly decreasing till the liquor was satiated.

But these *seven days*, here specified in the *Table*, containing all the considerable variety to be observ'd in this business, it would be *superfluous* and impertinent to trouble the Reader with any longer Diary, which was kept to the 4th. of *January* 1681 when the Increase in 24 hours amounted scarce to *half a grain*, and probably had the weather been then dry, it might have been none at all, or rather the liquor might have *lost* what before it had *gain'd*; as I shall observe by and by to some other purpose. But what is obvious to discourse upon the whole, relates either to the *Manner, Causes, Substance, Quantity* and *Time* of the *Increase*, or to the *Use* that may be made of the experiment in order to the discovering of the *changes* in the Air.

As to the first, the *more* our liquor was saturated, the *less* was its daily increase, though not *gradually* less by an even descent each day, but sometimes 2 or more natural days together it was exactly the *same*, a day or two after *less* and then again *more* the next day following according as the liquor stood affected by the heat or cold, dryness or moisture of the weather, the differing time of the day and quarter of the Wind. Thus upon the view of the whole Diary of almost two months; it appear'd, the increase was *more* in a Moist, Rainy, Misty, and Snowy, but *less* in a Frosty, Clear, and Dry Season, as also was *more* in a Cold than in a Warm Air.

When the Wind was Northerly or Easterly the gain was *less ceteris paribus* than when Southerly or Westerly, and was less in the day than in the night.

The *primary* cause of this *Phenomenon* seems to be the *Moisture of the Air*, which our liquor (a *potential* fire)

imbibes as greedily, as *actual fire* does the pabulum of Nitre, yet we must allow that all the other *Circumstances of Season* just now mention'd have each their particular influences in diversifying the *quantity* of the *Increase*. Thus it appears in the *Table* that *heat* alters the *progress* of increasing: For on the fourteenth day of *November* from 11 *mat.* to 11 *pm.* (at which time specially towards night) a very unusual and troublesome heat in the Air was complain'd of by several here in *Oxford*) in twelve hours the gain was only three Grains and $\frac{1}{2}$; whereas in the like time preceeding 'twas 10 Grains and $\frac{1}{2}$, and in that just following 9 Grains.

Neither indeed can any thing otherwise be expected from *Heat*, since thereby the *Moisture* might rather be exhal'd; or at least might be suspended, agitated and intimately *mixt* with the *substance* of the Air, and consequently not so easily be *Arrested* and *Entangled* by the surface of the Liquor, as when the Air is less hot. However allowing the effect of this *anomalous accident* at a time of the year when *least* expected, and considering that most commonly *Heat* keeps even pace with the *Season* of the year, depending as to its temper for the most part on the *Nearness* or *Remoteness* of the Sun; we may safely conclude *Moisture* the cheif and only *cause* of the *Increase* of *Weight* in *Oyl* of *Vitriol*, since in *Dry*, *Clear* weather it constantly increases *less* then in *Moist* and *Cloudy*, the circumstance of Heat or Cold remaining the *same* in *both*.

But this will be clearly evinced by an enquiry made into the *nature* of the *substance* gain'd, with the *Increase* of *Weight*. For by the ordinary wayes of tryal it appear'd the *Atmosphere* afforded our liquor nothing besides some of its *matry* particles, wherewith it always abounds, but more especially is ready to *part* with in *Moist* weather.

The *Air* without doubt has great variety of *different* *Substances* floating in it, whereof *some* particles do adhere
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here to *this*, some other sort to *that body*, according as either is peculiarly *dispos'd* to receive *one* sort rather than *another*. Thus the *Mortar* in the Joints of old Walls and Vaults from *Corpuscles* attracted from the *Air*, Sprouts out and frames a *peculiar* kind of *Salt*. I have known a Deal Shelve moisten'd only with the Liquor of *sixt nitre*, frosted over with Christsals of a perfect *inflamable* nitre by regaining the *proper acid* from the *Air*, all one as if so much *Spirit* of *nitre* had been pour'd on the said *Liquor*; I have seen a *Viol* half fill'd with *Oyl* of *Tartar per deliquium* (by being left open to the *Air*,) beset above the *Liquor* with peculiarly figur'd *Crystals*, and at the bottom were flat Christsaliz'd *plates* of a *Salt* which without flame crackled on a live *Coal* and left behind a *Calx* much like *Dr. Lysters nitrum Calcarium*. And tis well known *Colcothar* of *Vitriol* reimpregnated by the *Air*, will by a fresh distillation give you its proper *Acid* as at first. Now upon such *hints* as these, some (fond of the doctrine of *Alkali* and *Acid*) might perhaps expect, since differing Bodies of an *Alcalizate* nature do thus regain their *proper acids*, that *vice versa* even this most *acid Liquor* *Oyl* of *Vitriol* also might find its *Alcalizate* associate in the *Air*, from which the *violence* of *fire* had before driven it, but we could discover no such matter; the *tast* of our augmented *Liquor* was still purely *acid* and only weaker than before, whereas it would have been *Saltish* had an *Alkali* been combin'd with it, and its *colour* from a deep *reddish*, became *limpid*, all one as if the like quantity of fair water had been mixt; but to be more *certain* in this point I distill'd off the new *gain'd Substance*, at first it came over as *insipid* as clear water; and urging the *fire* farther, the drops prov'd *sowr*, the remaining *Oyl* in the *Retort* was altogether as *Corrosive* as at first, whence we may infer its *Edge* was not at all *blunted* by any adjoyn'd *Alkali*; so that what the *Air* afforded was nothing else but *meer water* only.

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As to the *quantity* of the whole Encrease it can't be determin'd by any general rule, since it varies according to the different *Strength* of the *Oyl of Vitriol* for it appears by the Table, the *more diluted* the Liquor, the *less attractive* it prov'd. This here employ'd (as highly *Phlegm'd* I presume as any usually is) gave a *triple and more* than $\frac{1}{2}$ of its first weight, amounting in all from three to nine Drams, and thirty Grains before it come to a *Stand*. Which *proportion* of Encrease I found confirmed in *lesser quantities* also; as, three Grains *Encreas't* to more then nine Grains; and one Grain gave the weight of something more than three Grains. But *besides the strength* of the Liquor; there are other *Circumstances*, as the *Season* of the year; and position of the *place*, which will certainly something alter this point; thus our liquor will gain more in *Winter* than in *Summer*; more in a *Cellar* and *Sunless* Room, than in a Room not so *qualifi'd*.

All these circumstances which relate to the *quantity* will also influence very much *the time* of the Encrease, the last thing to be consider'd in the experiment; but I shall only *mention* that which makes the most peculiar and *principal* variation in this point, and 'tis the *proportion of the Surface to the bulk of the Liquor*. For I find the *greater* or *less* the Surface is, the *quicker* or *slower* the Encrease. Thus three Grains dropt and diffus'd to nere $\frac{1}{4}$ Inch breadth on a peice of Glafs, gain'd three Grains in six hours, one Grain in six more, one Grain and $\frac{1}{2}$ in twelve hours more, in the next 12 hours gained $\frac{1}{2}$ a Grain, and in the last twelve hours it gain'd very little observable; So that in less then forty eight hours, having more then triple its first weight, it was for some time *fully satiated* till *Rainy weather* added something more.

But to discover *more nicely* what intrest the *proportion*

tion of Surface has in *hastening* or *retarding* the increase of weight, I expos'd in the same *Room* and to the same *temper of the Air* (as near as I could Guess) three Drams of the same Oyl of Vitriol in an open flat Glafs one *Inch Broad*, being only $\frac{1}{9}$ of the Diameter of that Glafs us'd at first with the like quantity. The result was this; that whereas the other Surface of *three Inches Diameter* gain'd (as in the Table) near nineteen Grains the first six hours, this *less Surface* gained a very little perceivable more then two grains in the same space of time. Now since the *Area's* of Circles are to one another as the *squares* of their *respective diameters*; as one the square of the *less* is to nine the square of the *greater* Glasse's diameter; So was the *weight* of a little more than two Grains gain'd in the *narrower Glasse* to near 19 Grains gain'd in the *broader*, wherefore *the time of Increasing bears* as near as can be expected an exact *proportion* to the *Surface* of the Liquor expos'd, and the liquor in the lesser Glafs having but $\frac{1}{9}$ part of the Surface of the greater, could not be satiated under *nine times as many days* as the greater. From what has been said it will also follow, that if this three Drams had a Surface in the same proportion- to the weight of a Scruple and a Grain *viz.* a little more than six $\frac{1}{10}$ Inches Diam. as that of $\frac{1}{3}$ Inch was to three Grains, the Increase of both would be *finish'd in the same time*, and would excuse the long attendance of any that shall think it worth while to *repeat* the experiment. Perhaps too the *different depth* of the Glafs together with the *more or less free access* of Air ought to be *attended to* in this affair: But thus much for the *circumstances* of the experiment.

The only *use* of it I can at present find will be to *estimate moisture and dryness in the Air* which is evidently *suggested* by this following observation: That when
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the *Oyl of Vitriol* is satiated, in the *moistest* weather; it afterward *retains* or *looses* its acquired weight as the Air proves *more* or *less* moist.

Thus the one grain above mention'd after its full Increase often *vari'd* its *equilibrium*, *viz.* in dry weather, the *weights*, in moist, the *liquor* did constantly *preponderate*, and that so *sensibly* that the tongue of the Ballance of $1 \frac{1}{2}$ Inch long describ'd an Arch of Variation to $\frac{1}{3}$ of an Inch compass; (which Arch would have been $2 \frac{2}{3}$ Inches (had the tongue been but *one foot* in length) even with that *little* quantity of Liquor, so that if *more* Liquor expanded under a *large* Surface be us'd, the *minute* alteration of *weather* must needs very much more affect it, and a bare pair of Scales will afford an *Hygroscope* as nice perhaps as *any* yet known.

This *Ballance* may be contriv'd *two ways*, either *such* whose pin should be in the *middle* of the *Beam*, with a *very slender tapering tongue* of a foot or one foot and a half long, pointing to the divisions on a *broad Arch'd plate fixt above* in the handle according to *figure the third in the Table*; or else the Scale with the Liquor may be hung to a point of the *Beam* very near the pin, and the other extream made so long as to mark a *large Arch* on a board plac'd conveniently for that purpose, as *the fourth figure represents*; The Scale in either may be a concave *Glass* of *four or five Inches Diameter*.

Lastly, on the division of the *Arches* should be inscrib'd the *different temperature* of the *Air* shewn by the Liquor. The fifth Figure gives the lineament of another *Hygroscope* made of a *Viol-string* running upon pulleys, and suspending a bullet fixt to the shorter end of an *Index*, whose other extremity is so long as to describe a *long Arch* by the *falling* and *rising* of the *Bullet* upon the *Stretching* and *Shrinking* of the *String*

which would be more nice, were the Index fastened to the center of the last pully. An experiment very obvious, but not taken notice of (as I know) by any writer, and so I thought it not impertinent to be mention'd here among *Hygroscopes*. But tis high time to conclude. I shall only add this *advertisement* that whereas in this experiment only *Oyl of Vitriol* was employ'd, I have reason to think that *Oyl of Sulphur per Campanam*, as also *Oyl of Tartar per deliquium*, and *the Liquor of Fixt Nitre &c.* may succeed as well; however, Sir, I must leave the prosecution and improvement of this and such like observations to persons who have better instruments and more leasure for such matters than,

Your humble
Servant.

W. G.

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